

ABDOMINAL
OPERATIONS
VOLUME II

ABDOMINAL OPERATIONS

BY

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VOLUME II



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PART VI

LIVER

CHAPTER 1

INJURIES OF THE LIVER

Injuries of the liver are of two types:

1. Subcutaneous.
2. Penetrating.

Subcutaneous Injuries. These are caused by blows, kicks or falls on the abdomen, by violent compression of the upper abdomen such as may occur in run-over accidents, etc., and by contre-coup injury resulting from a fall on the feet or head. There are three varieties of subcutaneous injuries:

(a) *True Rupture.* Here the capsule and parenchyma are torn, the commonest site of such laceration being at the upper border of the right lobe of the liver. The rent may be quite small—an inch or two in length, and extend just through the capsule; it may be jagged and deep; or again there may be multiple irregular fissures extending throughout the hepatic substance. In certain cases there may be complete division of the liver, or two or more portions of variable size may be torn adrift and lie among coils of blood-stained intestine. If during operation a piece of liver is observed to be torn off and is lying free in the peritoneal cavity, it should be removed on account of the risk of autolytic peritonitis. Boyce and McFetridge (*Arch. Surg.*, 34:977, 1937) have confirmed by numerous experiments that aseptic implantation of whole or ground liver into the peritoneal cavity of dogs produces death or an overwhelming "foaming" peritonitis in from eight to eighteen hours. In some few instances *B. welchii* have been recovered from the peritoneal fluid.

(b) *Subcapsular Rupture.* In this rather rare type of injury the capsule itself remains intact, but underlying portions of the parenchyma become pulped or otherwise damaged. A hæmatoma forms between the capsule and the liver substance, and at times this may become infected. Here again the right lobe of the liver is more frequently involved than the left. In many cases Glisson's capsule is literally stripped away from the underlying liver tissue for a con-

siderable distance, and blood rapidly collects between the liver and its capsule. The condition was first described by Brandenberg. Robertson and Graham (*Ann. Surg.*, 98:899, 1933) reported two cases of subcapsular rupture of the liver. They state that if a patient suffers an abdominal injury or distress referred to the right side and accompanied by pain in the right shoulder, early exploration is advisable as, should the diagnosis of subcapsular rupture of the liver prove to be correct, destruction of the liver tissue will be avoided and there will consequently be a shorter convalescence. They advise drainage of the hæmatoma for the early cases, and marsupialisation for the late cases, owing to the very real risk of contamination of the general peritoneal cavity with infected bile.

(c) *Central Rupture.* Here there is a localised contusion in the hepatic substance. Anderson (1925) was of opinion that this was produced by extreme bending or forceful torsion of the viscus. The liver is by far the most frequently injured abdominal organ.

Penetrating Injuries. Those due to stabs and gunshot wounds are three times commoner than subcutaneous injuries. Thus, Kreig (*Arch. Surg.*, 32:908, 1936) who reviewed 60 cases found that 68 per cent were due to bullet wounds, 15 per cent to stab wounds, and only 17 per cent to car and street accidents or to falls from a height.

Penetrating lesions are of three types:

1. Clean incisions produced by stabbing.
2. Clean punctures due to bullets.
3. Macerating punctures due to bullets, shell fragments, etc.

Gordon-Taylor, in *The Abdominal Injuries of Warfare*, writes:

The dimensions of the missile play no inconsiderable rôle in determining the type of hepatic lesion, which is almost protean in character: it may be a perforation, possibly with cracks and fissures radiating therefrom, a superficial "score" or gutter, a ragged wound, or a crateriform cavity. The liver is damaged in practically every abdomino-thoracic wound in the right side of the body, and may be badly shattered in such injuries as the "stove-in" chest. The whole organ may be disrupted even by a bullet wound, and as much as one-third of the right lobe has been found loose in the peritoneal cavity.¹

In Kreig's series the liver was the only organ involved in 40 cases, while in the remainder (20 cases) other organs also, especially the spleen, were injured.

¹ Gordon-Taylor, *The Abdominal Injuries of Warfare*, 1939.

Diagnosis. The diagnosis of subcutaneous wounds of the liver is always difficult and is often a matter of guess-work. There is the history of a blow or suchlike trauma to the right upper quadrant of the abdomen, following which the patient collapses. On examination there may be bruising or superficial abrasions over the right side of the chest or abdomen, there is tenderness and rigidity of the muscles guarding the injured area, and signs of shock or of internal hæmorrhage are in evidence.

A study of the case records will reveal that the majority are treated as cases of shock and surgery is invoked only when the patients are obviously exsanguinated. It is not surprising therefore that the mortality is often as high as 85 per cent. The case is somewhat different with penetrating wounds of the liver. Here the position of the wound of entrance gives a good clue as to what organs are or are likely to be implicated. The signs of loss of blood are noticeable, the upper abdominal muscles are on guard, tenderness can be elicited in the right hypochondrium, there may be dulness in the flanks, and the patient often complains of pain in the right shoulder.

Finsterer (1920) noticed bradycardia in a few of his cases and attributed this to the absorption of bile salts; but almost invariably the pulse-rate is rapid from the start. The temperature is at first sub-normal, but after a few hours it slowly mounts. The conjunctivæ may show a yellow tinge, although the skin of the body may be deathly white.

Prognosis. The prognosis depends mainly upon the type of injury, the condition of the patient on admission to hospital, and the length of time which elapses between receipt of the injury and operation. Subcutaneous injuries are about twice as lethal as penetrating wounds, this being due to the difficulties in diagnosis, but above all to the delay in undertaking operation and to the greater frequency of associated injuries to other abdominal viscera. Elder collected 189 cases of subcutaneous injuries of the liver and found that the mortality was 85 per cent when associated injuries were present. The death-rate from penetrating wounds of the liver varies from 30 to 50 per cent. Dean Lewis and Trimble (*Ann. Surg.*, 98:685, 1933) recorded 20 cases, 14 of which were operated upon with six deaths—40 per cent. In Boyce and McFetridge's series 43 cases were operated upon and 19 died—44.2 per cent. Stab wounds were the least fatal.



FIG. 197 —PRINGLE'S METHOD OF CONTROLLING THE HÆMORRHAGE FROM A LACERATED LIVER BY PINCHING THE FREE EDGE OF THE GASTRO-HEPATIC OMENTUM BETWEEN THE FINGER AND THUMB.

Treatment. These patients should not be rushed to the operating theatre and operated upon immediately they are admitted to hospital. As soon as a diagnosis of "ruptured liver" is made or suspected, the patient must, of course, be prepared for operation. This preparation may take an hour, or may take two hours or even more according to the circumstances of the case; it should, however, never be unduly prolonged to jeopardise the patient's chances.

An injection of omnopon and scopolamine is given to assuage pain and promote sleep. Heat is applied to the body, the abdomen is shaved and painted with alcohol, if abrasions or wounds are present they are suitably dressed, and citrated blood is introduced into the circulation by the Marriott drip method. If blood is not immediately available, an intravenous infusion of Ringer's or Hartmann's solution should be given.

The abdomen is explored through a right paramedian or midline incision. The liver should be carefully palpated, first the superior surface and then the inferior surface and edges. If a rent is discovered and the bleeding is brisk, Pringle's method (*Ann. Surg.*, 48:541, 1908) of controlling the hæmorrhage by pinching the free edge of the gastrohepatic omentum between the finger and thumb should be adopted (fig. 197). The hepatic artery and portal vein may also be controlled for a few valuable minutes by applying a curved enterostomy clamp in the manner illustrated in figure 197 (3), the blades having first been covered with rubber tubing.

The method of displacing the liver in order to expose its inferior surface is clearly shown in figure 198.

There are four methods of dealing with a wound in the liver: The rent may be packed or sutured, a subcapsular hæmatoma may be drained or marsupialised, and a severely pulped portion of the liver may be excised. Packing with a long strip of iodoform gauze may be indicated when the tear is situated in an inaccessible portion of the liver or when the patient is in a moribund condition and speed is essential.

Although packing has saved many lives, it is on the whole an unsatisfactory procedure. "The danger of this is that, while the method is successful for the time being, almost invariably septic conditions arise, and the patient dies in about a fortnight or three weeks from pylephlebitis." ²

² Mortimer Woolf, *Practitioner*, 133 571. 1934.

The packing should be removed by the surgeon himself on the third or fourth day after operation.

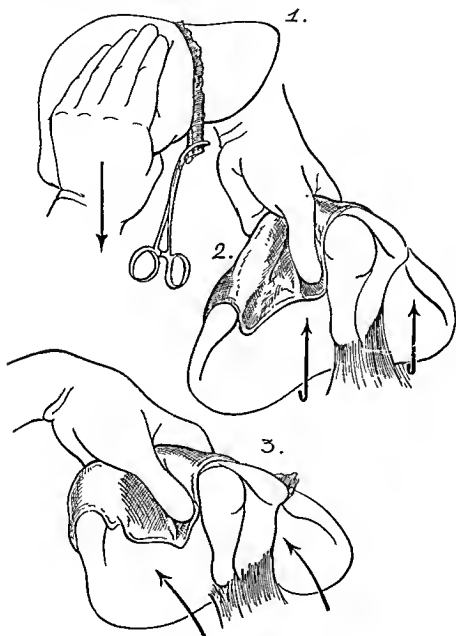


FIG. 198.—THE METHOD OF DISPLACING THE LIVER IN ORDER TO EXPOSE ITS INFERIOR SURFACE.

It should be stated that it is a rule that all accessible lacerations should be sutured and not packed. For extensive wounds in which

there is massive necrosis of hepatic tissue, resection is the best form of treatment. Rutherford Morison's method (*Brit. M. J.*, 1:6, 1914)

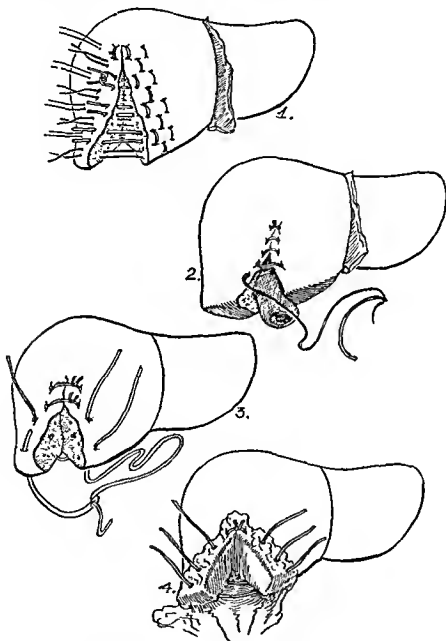


FIG. 199.—METHODS OF SUTURING THE TORN LIVER.

of suturing a deep tear in the liver by inserting tiers of mattress sutures is often employed (fig. 199 [1]), although the approximation of the edges of the liver by a series of interrupted through-and-

through stout ribbon sutures of catgut introduced on a special curved Kousnetzoff needle is the one which appeals to me (fig. 199 [3]). If the sutures tear out readily through the friable parenchyma, the great omentum may be brought across the laceration and the stitches passed as in figure 199 (4).

A recent subcapsular hæmatoma should be drained after incising Glisson's capsule and evacuating the pent-up blood by suction. But marsupialisation of a portion of the liver is preferable to this when the subcapsular collection of fluid is infected or contains an unduly large quantity of bile. In all cases, whether the rent in the liver has been sutured or packed with gauze, a drainage tube should be inserted into Morison's pouch on account of the risk of bile leakage from wounds in the ducts.

The surgeon should remember that other abdominal viscera, notably the spleen, are frequently concomitantly injured with the liver, and that this is especially the case with severe subcutaneous injuries. After having dealt with the hepatic lesion he should therefore examine the other organs expeditiously but thoroughly.

CHAPTER 2

LIVER ABSCESS

In a consideration of liver abscess it is imperative, both from a prognostic and therapeutic standpoint, to differentiate amœbic from pyogenic abscess. A rational study of liver abscess is impossible unless this differentiation is made from the outset. Such differentiation is essential, as in amœbic liver abscess the prognosis is good and the treatment simple, whereas in pyogenic liver abscess the prognosis is grave and the treatment most difficult.

AMŒBIC ABSCESS

Amœbic abscess is a disease of tropical countries or of those districts where indigenous amœbiasis abounds and results from the infection of the liver with *Entamoeba histolytica*.

The disease is extremely rare in the British Isles where indigenous amœbiasis is to all intents and purposes unknown. Rogers (*Brit. M. J.*, 2:845, 1902) was the first investigator to establish that solitary "tropical" abscess was caused by amœbic infection. According to Alton Ochsner and DeBakey (*Am. J. Surg.*, 29:173, 1935) the incidence of amœbic liver abscess in fatal cases of amœbic dysentery is approximately 38 per cent; but the incidence of amœbic abscess occurring in all cases of amœbic dysentery varies considerably according to different reports and apparently depends upon whether the case of amœbic dysentery has been ambulatory or not.

It would perhaps be fair to state that after taking all factors into account, in some 2 to 3 per cent of cases of amœbiasis liver abscess develops. The reports from India show that Europeans are more subject to liver abscess than are the natives. In Buchanan's series (*J. Trop. M.*, 1:73, 1899) there were 441 cases among the white inhabitants and 127 among the natives. Ochsner and DeBakey state that, in the Canal Zone, Herrick (*Surg., Gynec. & Obst.*, 2:422, 1910) found that the white employees from the U. S. A. were more

susceptible to amœbic liver abscess than the white employees from Europe, but that these in turn were more susceptible than the natives. The disease principally affects active men in adult life, the maximum age incidence being about 44. Children, and especially those of European descent, rarely suffer from this complaint. All authorities stress the rarity of the condition in females, the ratio of males to females being 8:1. In Hodgson and Brown's series (*Proc. Staff Meet. Mayo Clinic*, 13:625, 1938) there were only four females in a total of 35 cases. Manson-Bahr (*Med. Press & Circ.*, 201:376, 1939) writes:

Under modern conditions—possibly the result of systematic teaching of tropical medicine—the introduction of emetine and other effective anti-amœbic drugs, amœbic abscess is by no means as frequently encountered as in former days, when it constituted a real menace to the army in India and was attended by a high mortality, probably due to the operative methods at that time employed. It has been stated that liver abscess is a sequel to amœbic dysentery, but this requires some further explanation. It is not to be inferred that liver abscess *cannot* take place without a history of tropical intestinal amœbiasis—diarrhoea, abdominal pain, with blood and mucus in the stools; on the contrary, it is much more likely to ensue in those individuals who have acquired a symptomless infection or who are indeed “carriers” of *Entamoeba histolytica*. More often than not, it steals like a thief in the night and the illness commences sullenly and insidiously when there are no indications of intestinal disturbance at all. The explanation appears to lie in the facility with which the amœba invades the cæcum and makes its way from that situation via the mesenteric veins into the liver. It therefore comes about that liver abscess is by no means always an accompaniment of acute intestinal amœbiasis—which may ensue 20 years, or even longer, after the date of the original infection.¹

In approximately 70 per cent of the cases the abscess is single, while in the remaining 30 per cent multiple abscesses are scattered throughout the right lobe of the liver or involve both lobes.

The solitary abscess occupies the right lobe in 90 per cent of the cases, the favourite site being the superior and posterior regions.

In chronic amœbic abscess the pus is thick and yellow in colour, whereas in the more acute cases it is either of a reddish or a chocolate hue. It contains few or no leucocytes, and is composed chiefly of cellular detritus and blood. Active amœbæ are very rarely found in aspirated pus (17 per cent) and seldom if ever in chronic cases. They

¹ Manson Bahr, *Med. Press & Circ.*, 201:376, 1939

are most likely to be recovered from small abscesses and are found adherent to the necrotic wall. There is little or no leucocytic infiltration around the abscess, but a fibrous tissue barrier is slowly laid down, shutting off the abscess. Amœbic hepatitis may subside spontaneously or under emetine treatment, or it may progress to liquefaction. This liquefaction—the chocolate-coloured pus—has been shown by Craig (*Am. J. Trop. M.*, 7:225, 1927) to be due to proteolytic activity of a soluble toxin produced by the amœbæ. If left untreated the abscess may rupture in various directions (fig. 200 [A]). Usually the maximum suppuration occurs in the superior and posterior portions of the right lobe in proximity to the cupola of the diaphragm so that intra-pleural or intra-pulmonary rupture is of most frequent occurrence. The abscess may rupture into a bronchus and be coughed up, or it may burst into the pericardium, stomach, duodenum, colon, general peritoneal cavity, into Morison's pouch, or through the abdominal or chest wall. When the skin becomes involved, large areas may be rapidly destroyed by a process of spreading gangrene. A large abscess may completely destroy the right lobe of the liver and convert it into a bag of pus. The left lobe in such cases undergoes a compensatory hypertrophy.

Clinical Picture. The clinical picture is fairly distinctive. Amœbic hepatitis manifests itself as a pyrexial illness with enlargement and tenderness of the liver in an individual who gives a history of dysentery and of amœbæ in the stools.

The systemic manifestations of amœbic liver abscess are fever of the intermittent or remittent type, with drenching night sweats, weakness, loss of weight, nausea, anorexia, malaise and vomiting. A mild degree of jaundice is noticeable in about 10 per cent of the cases, while rigors are said to occur in 25 per cent. The local manifestations include pain and tenderness in the right upper quadrant of the abdomen, more especially beneath the right costal margin, enlargement of the liver and limited movements of the right side of the chest. Pain is often referred to the right shoulder, scapular region, and right iliac fossa. Rarely the abscess may form a fluctuating tumour appearing beneath the ribs, and sometimes œdema of the thoracic and abdominal walls can be made out. Tenderness on pressure over the right chest wall may point to the site of the abscess, and in some cases deep breathing and coughing may cause pain.

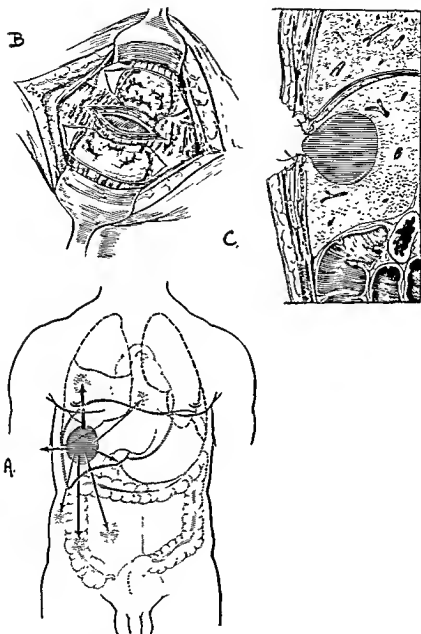


FIG. 200.—AMOEBIC LIVER ABSCESS.

(A) Diagram to indicate the commonest directions in which amoebic liver abscess may rupture.

(B) and (C) show the transpleural route which is sometimes employed for drainage purposes.

Especially characteristic is the pain caused by sudden movement such as turning over in bed, and in order to prevent this to some extent the patient keeps his arm pressed to his ribs ("carries his abscess under his arm").

There is commonly something distinctive about the hepatic facies—the muddy ochreous complexion with dark circumorbital rings. The base of the right lung often shows changes such as impaired air entry, crepitation, and even consolidation from inhibition of diaphragmatic movements and sympathetic congestion of the lung due to the contiguous inflammatory process in the liver.

Diagnosis. If the condition is borne in mind the diagnosis of amœbic hepatitis abscess is not difficult. There is usually a previous history of dysentery, but the absence of such a history does not by any means rule out the possibility of amœbiasis. There are pain and tenderness over the liver, which may be enlarged, while a dull troublesome ache in the right shoulder is significant. Examination of the blood shows a mild secondary anæmia and a slight leucocytosis without concomitant proportionate increase in the polymorphonuclear leucocytes. The white cells usually number 15,000 to 20,000 per cu. mm., a higher figure than this seldom being seen except, of course, in cases where there is frank suppuration. Repeated microscopic examinations of the fæces must be carried out in every case, and a search made for active amœbæ or encysted forms. Negative findings do not exclude amœbiasis as a cause of the liver involvement, since amœbæ are demonstrated in only some 45 per cent of the cases. The greatest help will be obtained by a fluoroscopic examination of the liver and right side of the chest and by observing the fixation of the diaphragm and upward projection of the cupola into the lower lung field. Straight X-ray films are taken after the screening, and these often confirm the screen findings. It is a rare event to be able to visualise the confines of an abscess in a skiagram unless the margins have undergone calcification; but occasionally the area of lesser density presented by the pus produces a darker shadow on the negative and is of assistance in locating the abscess. Evidence of actual amœbic ulceration of the colon is difficult to obtain. Sometimes infiltration of the sigmoid colon can be made out on palpation, and at times too there is a similar thickening in the cæcum or ascending colon. Sigmoidoscopy as a method of proving the persistence of

amœbic ulceration is often disappointing, as the lesions are commonly situated in the upper reaches of the colon, well out of the range of vision of the sigmoidoscope.

The most practical method of all of demonstrating the presence of an abscess is by means of aspiration and drawing up of the liver pus into the exploring syringe. The aspiration should always be performed in the operating theatre and the pus withdrawn should be microscopically examined immediately to determine if pyogenic organisms are present in the fluid.

The actual technique of aspiration depends considerably upon the clinical manifestations. In those cases in which there are localising signs and *pointing* of the abscess, the aspirating needle should be introduced directly into the affected area; if there are no localising signs it is important to introduce the needle in such a way that the pleural and peritoneal cavities are not traversed. At times an abscess may be reached by introducing the needle below the twelfth rib and extending it upward and anteriorly.

Although amœbic pus is sterile in fully 86 per cent of cases it is advisable always to observe these precautions.

Prognosis. The prognosis depends upon: (1) the general condition of the patient; (2) the type of treatment employed; (3) the presence or absence of secondary infection of the abscess cavity, and (4) the number of abscesses present and the virulence of the infection.

If the amœbic infection is severe and there are multiple abscesses in the liver, the outlook is extremely grave; if, on the other hand, there is a solitary abscess and on aspiration the pus is found to be sterile, the prognosis is relatively good.

The importance of closed drainage in uncomplicated amœbic liver abscess is stressed by all authorities. Rogers (*Lancet*, 1:569, 1922), in his Lettsomian Lecture, showed that the death-rate following open drainage was 56.8 per cent, but that this was reduced to 14 per cent when the closed drainage method was generally adopted. In the open operation most of the deaths are directly attributable to the onset of secondary infection of the abscess wall. Chatterji (*Indian M. Gaz.*, 57:333, 1922) reported that the death-rate in his series was only 1.6 per cent, and he attributed his success to the employment of the closed drainage method. In Ochsner and DeBakey's series the mortality of 19.5 per cent was obtained; in 46 cases in which conserva-

tive treatment was employed there was only one death—4.1 per cent. In a series of 4,035 cases collected from the literature by these authors, in which open operation was carried out, 1,908 (47.2 per cent) ended fatally, whereas in a series of 459 in which conservative treatment was used, only 32 (6.9 per cent) died.

Treatment. In most cases of acute amœbic hepatitis emetine acts as a specific. The usual dose is 1 gr. of emetine hydrochloride injected subcutaneously daily for six to eight days, followed by $\frac{1}{2}$ gr. of emetine bismuth iodide for ten consecutive nights. Daily rectal retention enemata of 2.5 per cent of quinoxyl or yatren should be ordered for a similar period in order to eradicate the infection.

This treatment is also highly efficacious in those cases in which the abscess is very small. Where the abscess is large, pre- and post-operative medication with emetine is also imperative. The average pre-operative dose of emetine is 6-8 grs., the maximum dose of 10 grs. never being exceeded owing to the damage it is liable to inflict upon the heart muscle (Leake).

As previously stated, aspiration of the pent-up pus in the liver should be carried out in the operating theatre. If the pus proves to be sterile, the abscess should be evacuated by means of a Potain apparatus. A small area of skin should be anæsthetised with novocaine, a short incision made, and the aspirating needle inserted along the tract where the abscess appears to be situated. As soon as pus is struck, fluid wells up into the container of the apparatus, and a pint or more may be evacuated in a few minutes. If the pus is very thick and there is difficulty in evacuating it into the bottle, the process may be facilitated by injecting a dilute solution of ensol into the cavity.

After aspiration, a firm binder is applied and the patient continues to receive emetine daily. If the pus is very thick and cannot be evacuated, or if it is mildly infected, drainage is first effected by means of a tube inserted through a large cannula passed along the line of the aspirating needle. If the rubber tube is passed through the cannula on the stretch and the cannula is removed, the tube when released will fill the cannula track very tightly, thus arresting leakage and bleeding.

If the aspirated pus is teeming with pyogenic organisms, then resort must be had to open operation and efficient drainage. When

there is a large collection of pus bulging anteriorly below the costal margin, marsupialisation should be employed. A small transverse sub-costal incision is made over the abscess, and when this is reached a finger is inserted into the cavity and after the pus has been evacuated the margins of the liver wound are carefully sutured to those of the abdominal wound. Special care should be taken to prevent contamination of the general peritoneal cavity by cautiously packing off the infected zone. The cavity in the liver is then drained by the Carrel-Dakin method.

When infected pus has been reached posteriorly between the seventh and eighth or eighth and ninth ribs, the trans-pleural route should be employed for drainage purposes. Portions of adjoining ribs are resected and the diaphragm and capsule of the liver are stitched to the parietes in the manner shown in figure 200 (B and C). Here again, after the evacuation of the abscess it is good practice to insert a large drainage tube, employing the Carrel-Dakin method. An abscess situated in the posterior part of the right lobe can be drained most efficiently by resecting the twelfth rib and by pushing the pleura upward and then inserting a drainage tube into the liver extraperitoneally.

PYOGENIC ABSCESS

In pyogenic liver abscess the micro-organisms gain access to the liver:

1. Via the portal vein from areas drained by the portal system, *e.g.*, appendix.
2. Via the hepatic arteries, *e.g.*, in cases of septicæmia, furunculosis, etc.
3. By direct extension, *e.g.*, from diseased gall-bladder.
4. From without, *e.g.*, through perforating wounds of the liver.
5. As the result of subcutaneous injuries of the liver. Here the devitalised hepatic tissue encourages the growth of micro-organisms already present in the liver.
6. By routes which are difficult or impossible to determine—primary, idiopathic or cryptogenic pyogenic liver abscess.

Accurate estimation of the frequency of pyogenic liver abscess is most difficult, as the diagnosis cannot always be made and many cases in which post-mortem examinations are not made undoubtedly are

overlooked. Collins (*Minnesota Med.*, 15:756, 1932) found 111 cases in 18,300 autopsies—0.6 per cent. The disease is approximately three times commoner in the male and the greatest age incidence is found in the third and fourth decades. The most frequent antecedent lesion is suppurative appendicitis which is complicated by portal thrombophlebitis (pyelephlebitis). Alton Ochsner, DeBakey and Murray (*Am. J. Surg.*, 40:292, 1938) in an exhaustive and authoritative review of this subject stated that in a collected series of 575 cases there were 197 (34.2 per cent) in which appendicitis was the ætiological agent. In a series of 68,198 cases of appendicitis there were 247 cases of septic liver abscess, an incidence of 0.36 per cent. Other lesions in the portal area which are responsible for some 8 to 10 per cent of cases are chronic gastric and duodenal ulceration, cancer of the stomach, diverticulitis, colitis, carcinoma of the colon, septic hæmorrhoids, proctitis, suppurative pancreatitis, etc. Pyogenic liver abscess is caused by direct extension from contiguous suppurative processes more frequently than is generally stated to be the case (6 to 14 per cent). In this group are included calculous cholecystitis, suppurative cholangitis, and subphrenic space infection. In penetrating injuries, e.g., gunshot wounds, stabs, etc., micro-organisms may be carried from without into the hepatic substance and light up a suppurative process, while in subcutaneous injuries the pulped portion of the parenchyma acts as an excellent medium for the growth of micro-organisms which are always present in the liver.

Septic liver abscess may be produced by micro-organisms which are transported via the hepatic artery from distant septic foci. Such blood-borne infections may be due to osteo-myelitis, carbuncle, boils, acute infective endocarditis, upper respiratory tract infections, and any condition in which there is generalised sepsis, e.g., extensive burns.

Of the 575 collected cases of liver abscess analysed by Ochsner, approximately 13 per cent were due to metastatic infections of this type. Finally, there is a comparatively large group of pyogenic hepatic abscesses in which the antecedent lesion cannot be determined by any means at our disposal, and which for this reason has been termed primary, idiopathic or cryptogenic pyogenic liver abscess. Rothenberg and Linder (*Surg., Gynec. & Obst.*, 59:31, 1934) consider that such abscesses are the result of systemic blood-borne

infections due to distant foci which may be so insignificant as to be overlooked. Beaver (*Am. J. Path.*, 7:259, 1931), on the other hand, formed the opinion that in most of these cases the micro-organisms are transported via the portal vein and that the antecedent lesions in the portal area are so minute that they pass unrecognised.

In about 50 per cent of cases the pus in pyogenic liver abscess is found to be sterile. The organisms most frequently found are *B. coli*, streptococci, staphylococci, or a combination of some or all of these. Other micro-organisms which on very rare occasions cause liver abscess are *B. pyocyaneus*, *B. typhosus*, *B. welchii*, gonococci, streptothrix and spirochetes. In non-tropical countries appendicitis is the commonest cause of hepatic abscess.

The proper genesis of this infection is rather easy to follow. In the course of inflammation of the appendix, thrombo phlebitis of the appendiceal intramural vessels invariably occurs. The phlebitis can involve progressively the appendiceal veins in the meso-appendix, the ileocecal, the superior mesenteric, and the portal veins, or a small septic embolus can become detached from the thrombus in the immediate neighbourhood of the inflamed appendix and be transported through the contributing venous channels and portal veins of the liver. This is the manner of development of the classical liver abscess which follows appendicitis. These abscesses are usually multiple and for the most part occupy the right lobe. The explanation of the latter lies in the experimental work of Séregé, Glenard, Bartlett, Corper and Long, and Dick and Copher, who have demonstrated the existence of two currents of blood in the portal vein, one from the superior mesenteric which goes to the right lobe and one from the inferior mesenteric and splenic vein which goes to the left lobe.²

Clinical Picture. The clinical picture is not unlike that of hepatic amœbic abscess. The symptoms are pyrexia of a remittent or intermittent type associated with rigors and profuse sweating. There are, in addition, malaise, weakness, nausea and anorexia. Vomiting occurs in about 30 per cent of the cases. Pain is felt in the right upper quadrant of the abdomen, in the area occupied by the liver, and especially below the right costal margin. At times pain is referred to the right shoulder region, this being caused by phrenic irritation.

On examination the patient looks ill, wasted, waxy and cachectic. Jaundice, when present, is always an ominous sign. The liver is enlarged and exquisitely tender, and there may be œdema of the chest wall in the immediate vicinity of the inflammatory process, while

² Ochsner, DeBakey and Murray, *Am. J. Surg.*, 40 292, 1938

there may also be signs of consolidation of the base of the right lung or fluid in the pleural cavity on that side. There is a marked leucocytosis (20,000 to 30,000) with a corresponding increase in the polymorphonuclear leucocytes. X-ray examination of the chest is of great value in diagnosis, in fact it is an essential method of investigation. In a well-established case the diaphragm is elevated and fixed, usually on the right side.

Exploratory aspiration of the liver for the detection of pus in pyogenic hepatic abscess is an unjustifiable and dangerous procedure, since the danger of contaminating the pleural or peritoneal cavity is always present if this is attempted.

Diagnosis. The diagnosis may be correctly made in about 80 per cent of the cases on the clinical manifestations and on the laboratory and X-ray investigations alone. In cases of suppurative appendicitis associated with chills and perhaps a tinge of jaundice, the diagnosis is rarely, if ever, in doubt.

Prognosis. The prognosis depends upon: (1) the condition of the patient and the virulence of the organisms; (2) the multiplicity of the lesions and whether or not there is associated pyelephlebitis; (3) the position of the abscess and the presence or absence of complications; (4) the type of drainage operation which has been adopted.

The prognosis is exceedingly grave in the case of multiple abscesses—70 to 80 per cent, but slightly better in the case of the solitary abscess which is uncomplicated—40 to 50 per cent. The commonest complications are rupture of the abscess into the pleural cavity or into the lung, thrombosis, embolism, septicæmia, localised or generalised peritonitis, and subphrenic abscess, and when these occur the prognosis may be said to be well nigh hopeless.

The type of treatment employed for a solitary abscess has an important bearing on the results obtained. Thus, when operation is for one reason or another withheld, the mortality is 100 per cent; when the trans-abdominal approach is used for the employment of drainage it is about 70 per cent; when the trans-pleural method is instituted it is approximately 66 per cent; but when the extra-serous approach is chosen it may be as low as 33 per cent.

Treatment. The treatment of *solitary pyogenic hepatic abscess* consists of incision and drainage as soon as the diagnosis is made, in such a way that uninvolved serous cavities are not contaminated with pus.

The trans-pleural method of approach, which was first suggested by Trendelenburg (1883) for drainage of a subphrenic abscess, is now never employed as it is associated with such a damning mortality. Likewise the trans-peritoneal approach is nearly always followed by a diffuse peritonitis.

If during an exploratory laparotomy a pyogenic abscess of the liver is found, it is most important not to attempt drainage of the abscess at this stage. Adhesions between the peritoneal surface of the liver and the overlying parietal peritoneum should be produced by such means as a gauze pack which has been lightly moistened with a weak solution of tincture of iodine, and drainage through this area performed two or three days later when protective adhesions have formed.

An abscess which is situated anteriorly in the right lobe of the liver should be approached by the extraperitoneal route. This is accomplished by making a transverse incision immediately below the costal margin through all the layers of the abdominal wall down to the peritoneum. The peritoneum is then freed with the fingers or by gauze dissection in an upward direction until the edge of the abscess is reached. A finger is then inserted into the abscess cavity, and after the pus has been evacuated a drainage tube is introduced into the cavity and sutured to the skin incision (fig. 201 [1]).

If the abscess is situated posteriorly the most logical method of drainage is by the retroperitoneal approach so warmly advocated by Ochsner and his associates. This operation consists of making the skin incision directly over the twelfth rib, and after performing a sub-periosteal resection of this rib, a transverse incision is then made through its bed at the level of the spinous process of the first lumbar vertebra. The finger is introduced through this incision into the retroperitoneal space between the upper pole of the kidney and the inferior surface of the liver (fig. 201 [1 a]). Mobilisation of the parietal peritoneum from the under-surface of the diaphragm can be readily performed. In this way the liver abscess can be drained completely extra-serously. This is the ideal approach to the abscess, and the one which yields the best post-operative results.

During the first few post-operative days citrated blood is given by the slow drip method, and sulphanilamide or sulphapyridine therapy is instituted.

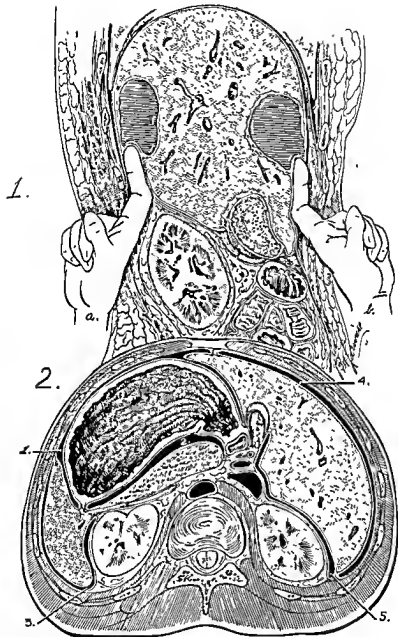


FIG. 201.—(1) SOLITARY PYOGENIC HEPATIC ABSCESS.

Methods of draining such abscesses by the extra-serous routes. (a) retro-peritoneal approach for a posteriorly-situated abscess. (b) anterior extra-peritoneal route.

(2) DIAGRAM SHOWING ANATOMICAL RELATIONSHIPS OF FOUR TYPES OF SUB-PHRENIC ABSCESS.

(1) Left anterior intra-peritoneal; (2) left posterior intra-peritoneal; (3) left posterior intra-peritoneal; (4) right anterior intra-peritoneal, (5) right posterior intra-peritoneal.

Melchior (*Zentralbl. f. Chir.*, 54:3083, 1927), Thalhimer (*Arch. Surg.*, 8:658, 1924) and other surgeons have stressed the importance of examining the ileocolic and superior mesenteric veins during operation for acute appendicitis in every patient who has given a history of rigors. If the ileocolic vein is thrombosed, they recommend ligation of this vessel in order to prevent further septic emboli from being carried to the liver.

Braun (*Beitr. z. klin. Chir.*, 86:314, 1931) was one of the first to suggest that if during the post-operative course following appendectomy for acute appendicitis chills developed, this was very significant of pyelephlebitis. In such cases he would advise that the abdomen be re-opened and that the ileocolic vein be ligatured in continuity to arrest the stream of emboli to the liver.

CHAPTER 3

NEOPLASMS OF THE LIVER

Such organs as are the frequent sites of secondary tumours rarely exhibit the primary type (Virchow).

CLASSIFICATION

(A) *Benign Tumours.*

1. Adenoma:

(a) Liver cell adenoma (benign hepatoma).

(b) Bile duct adenoma (benign cholangioma).

2. Lymphangioma.

3. Hæmangioma.

4. Myoma.

5. Teratoma.

(B) *Malignant Tumours.*

1. Primary tumours:

(a) Carcinoma; (i) liver cell carcinoma (malignant hepatoma); (ii) bile duct carcinoma (malignant cholangioma); (iii) mixed cell type containing elements of both (i) and (ii).

(b) Sarcoma: (i) round-celled; (ii) spindle-celled; (iii) alveolar; (iv) angiosarcoma.

2. Secondary tumours.

Benign Tumours. The commonest type and by far the most interesting is the adenoma. Myoma, hæmangioma, lymphangioma, teratoma, etc., are found in the liver on rare occasions, but they do not call for any special mention. Schrager (*Ann. Surg.*, 105:33, 1937) states that an adenoma of the liver may attract attention on account of the presence of a tumour in the upper abdomen. The mass may remain clinically silent for a considerable period, or may so interfere with the function of neighbouring viscera by pressure or dis-

placement, especially upon the biliary channels or blood vessels, as to cause grave and urgent symptoms. Occasionally an adenoma is discovered during an abdominal exploration or it may be found at post-mortem examination. An adenoma of the liver may occur at any age, but many of the reported cases have been observed in infants or young adults.

There are two main varieties: (1) liver cell adenoma (hepatocellular); and (2) bile duct adenoma (cholangio-cellular).

The former, which has a predilection for the right lobe of the liver, is nearly always single, brown or grey in colour, soft in consistency, and encapsulated. It follows the pattern of the liver lobule; the strands of polyhedral cells, however, are not regularly arranged around a central vein as in the normal hepatic lobule. The cells, too, are larger, often contain fat globules, and may secrete bile.

The acinous type may be transformed into the tubular type if bile secretion occurs and if there is a central disintegration of the tumour or if hæmorrhage takes place. These evolutionary changes may go beyond this stage and form a cystic adenoma—solitary cyst of the liver. Schrager writes:

The bile duct adenoma (tubular adenoma) is greyish on account of the richness of connective tissue. It consists of woven strand cells resembling bile ducts. The cells are columnar and according to Gasparin they occur most commonly in men of advanced age. The epithelium of these cells may become ciliated, as was the case with the tissue studied by Cagnetto. These adenomata belong to the functioning types of tumours. According to Rolleston, bile-duct adenoma has a tendency to indent and displace but not invade the surrounding liver substance.¹

Adenoma of the liver is held by many authorities to be a reparative phenomenon in cirrhosis of the liver, as well as other destructive processes such as syphilis, malaria, venous engorgement, and sepsis (Yamasaki). It is an interesting fact that the cirrhosis was noted to be concomitantly present in many of the recorded cases. These tumours are prone to undergo fatty, cystic or malignant degeneration. Although they are usually pure tumours, occasionally they may be mixed, in which portions of adenomatous tissue are intermingled with a Grawitz hypernephroma or even with cartilage cells or pigment pavement epithelial cells.

¹ Schrager, *Ann Surg.* 105 33, 1937 Courtesy of J. B. Lippincott Co.

Symptoms and Signs. There are no characteristic symptoms and signs of adenoma of the liver. The symptoms are due to compression of the gall-bladder, bile ducts, neighbouring blood vessels, the stomach, the duodenum, or the pelvis of the right kidney, and to various complications or alterations which may occur in the tumour itself. There may therefore be a dull pain in the back or shoulder region, jaundice, flatulence, dyspepsia, or symptoms pointing to obstruction of the outlet of the stomach, urinary manifestations, or the typical picture that is presented by an advanced case of cirrhosis of the liver.

The signs are those of a tumour in or about the liver. If the tumour arises in the left lobe of the liver, it may displace the stomach downward and produce a midline epigastric tumour which closely resembles a pancreatic cyst. X-ray examination of the kidneys by retrograde pyelography, of the stomach by barium meal, and of the gall-bladder by Graham's dye test, peritoneoscopy, and laboratory methods may, on occasion, prove of some help in diagnosis. The diagnosis is always in doubt until a microscopical examination of the tumour is made, and even then serial sections must be cut through the entire growth to establish its benignity.

Adenoma has to be distinguished from other tumours of the liver proper, such as primary carcinoma, primary sarcoma, myoma, and so forth, from cystic tumours such as echinococcus cyst and solitary cyst, from localised tuberculoma, from the large single gumma, and from the encapsulated ectopic hypernephroma of the liver.

Treatment. If the tumour is pedunculated, and it may be so on occasions, its moorings to the liver should be transfixed, ligatured and divided, after which the growth may be freed from surrounding adhesions and delivered through the abdominal wound. Rubin (*Am. J. Obst.*, 77:293, 1918) reported a case of pedunculated hæmangioma which gravitated into the pelvis and interfered with a pregnant uterus. He was able to remove the tumour successfully.

If a cystic adenoma becomes large and is dragged downward, it may be confused with an ovarian cyst. If the tumor is partially embedded in the parenchyma it should be shelled out of its capsule and the resulting space obliterated by interrupted sutures of stout catgut; or again it may be removed by wedge resection of a portion of the liver, planned so as to include the tumour. After wedge resection the

margins of the liver are approximated in the manner portrayed in figure 202 (2).

Malignant Tumours.—Primary Carcinoma. The incidence varies from 0.05 to 1.15 per cent of all necropsies. In a recent series of 435 cases of malignant disease of the liver studied by Martinez (*Med. Press & Circ.*, 201:414, 1939) there were 5 cases of primary hepatic cancer—an incidence of 1.15 per cent. Gustafson (*Ann. Int. Med.*, 11:899, 1937) found 62 cases in 24,400 autopsies, or 0.257 per cent; K. J. Smith (*J. Lab. & Clin. M.*, 18:915, 1933) reported 25 primary carcinomata in 4,044 autopsies, or 0.60 per cent; while reports from continents such as Asia and Africa cite 416 cases of primary cancer of the liver in 39,701 autopsies, an incidence of 1.05 per cent.

The disease is most frequent in the fifth and sixth decades, although according to Kilfoy and Terry (*Surg., Gynec. & Obst.*, 48:751, 1929) many cases have been recorded in infants and in children. The youngest case was reported by Steiner (*Am. J. Dis. Child.*, 55:807, 1938)—a primary carcinoma in a male of four months. All authors are agreed that the disease affects males more frequently than females. Thus, Greene (*Surg., Gynec. & Obst.*, 69:231, 1939), in reviewing 386 cases, found the ratio to be 6:1.

The following classification based on the histological features of the tumours has been suggested by Ewing (*Neoplastic Diseases*, 3rd ed., 1931):

1. Hepatoma. These growths arise from the cells of the liver parenchyma.

2. Cholangioma. Here the cancer arises from the epithelial lining of the intra-hepatic bile ducts.

3. Mixed type, containing elements of both.

The hepatoma is the commonest. In Tull's series (*J. Pathol. & Bacteriol.*, 35:557, 1932) there were 99 hepatomata to 35 cholangiomata. Yamagiwa (*Arch. f. path. Anat.*, 206:437, 1911) originally described three macroscopical types:

1. The nodular. This is the commonest and is highly malignant and exuberant in its growth. It is represented as multiple pale grey, blood- or bile-stained, breaking down nodules, usually involving the entire organ.

2. The massive. This is characterized by a huge solitary white or

yellowish soft mass, often occupying the entire lobe of the liver. At times it is ringed with small secondary nodular growths.

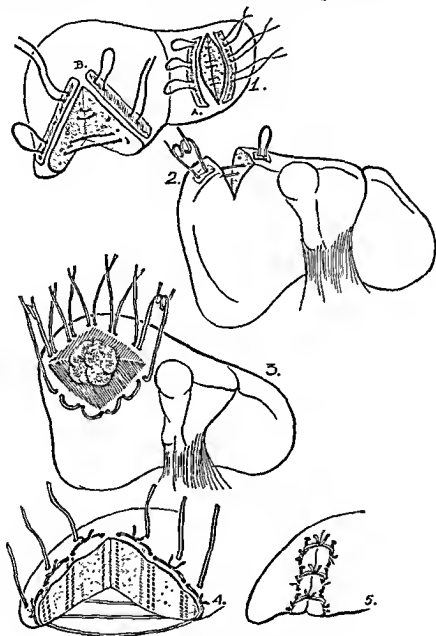


FIG. 202.—PARTIAL HEPATICOTOMY.

Methods of suturing the defect in the liver after removal of the tumour. (After Payr and Martina and Van Buren Knott).

3. The diffuse. Here the malignant process appears to extend throughout the whole liver substance. The organ may be contracted

or enlarged and superficially resembles cirrhosis. According to Eggel (*Beitr. z. path. Anat.*, 30:506, 1901) cirrhosis is found in 85 per cent of hepatomata and in 50 per cent of cholangiomata, and is a frequent precursor of the malignant process itself. Strong and Pitts (*Ann. Int. Med.*, 6:485, 1932) state: "It is our impression that primary carcinoma of the liver invariably develops on a basis of cirrhosis." Martinez believes that the sequence of cirrhosis, regenerative nodular hyperplasia, multiple adenomata, and finally carcinoma, is a well-established fact. He states that in districts where parasitic diseases, such as distomiasis and schistosomiasis are common causes of liver damage, primary hepatic carcinoma is relatively frequent. Thus, L. W. Smith (*Arch. Path.*, 1:365, 1926) writes that the ante-mortem diagnosis is readily made in the Philippine Islands, and Strong and Pitts (*Arch. Int. Med.*, 46:105, 1930) point out that the disease is usually prevalent among the Chinese patients who are admitted to the Vancouver General Hospital.

CLINICAL PICTURE. Primary carcinoma of the liver is not associated with any characteristic clinical picture. In most cases the onset is insidious and there is a progressive loss of weight, anæmia, and discomfort in the epigastrium or right hypochondrium. The liver slowly but steadily enlarges, ascites develops, and the patient becomes emaciated. Jaundice is present in about 50 per cent of the cases, and the spleen becomes palpable in a little less than one-third. Fever and a slight degree of leucocytosis is sometimes present, especially in the rapidly growing type. The disease is most eager in its course and death usually takes place in three to four months from the onset of the first symptoms.

A correct pre-operative diagnosis may on occasion be reached by means of the ingenious operating peritoneoscope devised by Ruddock (*Surg., Gynec. & Obst.*, 65:623, 1937). Most cases are diagnosed as secondary malignant disease of the liver; the rapid and progressive enlargement of the liver, the constant dull pain in the right hypochondrium, the steady loss of weight and of strength, the deepening jaundice, the anæmia and the ascites are all characteristic features of massive involvement of the liver with a disease that invariably proves fatal.

In the early stages the disease is clinically silent, and does not arouse attention unless fortuitously it is situated in the margin of

the liver where it may be felt as a hard nodule demanding immediate surgical inquiry.

Cirrhosis, syphilitic infiltration of the liver, hydatid cyst, hepatic abscess and gall-stone obstruction of the common bile duct have all to be considered in the differential diagnosis.

TREATMENT. For the diffuse primary growth and for the multiple nodular tumours nothing surgical can be attempted nor is deep X-ray therapy or radium treatment of any avail. Palliative measures directed toward the relief of pain and paracentesis when the abdomen is filled with fluid is about all that can be offered. For those rare but fortunate cases where on exploration an accessible solitary primary tumour of the liver is discovered, resection—partial lobectomy—should be undertaken, especially when its margins are clearly defined, when it is certain that the whole tumour can be removed and that such a margin can be cut away as to make it hopeful that recurrence will actually be prevented or at least postponed for a long while.

There are numerous instances in the literature of successful partial hepatectomy for primary carcinoma of the liver. Yeomans (*J. Am. M. Ass.*, 64:1301, 1915) was able to tabulate from the literature 16 cases of operations for primary carcinoma of the liver. Of these 16 cases four patients died within a fortnight, six had recurrence in periods varying from two months to eight years, while six were alive and well from three to seven years subsequent to operation. Grey Turner (*Proc. Roy. Soc. Med.*, 16:43, 1923) described the successful removal of a malignant hepatoma weighing over 21 lbs. from the right lobe of the liver of a boy aged 13. The patient lived for nearly two years after this heroic and successfully planned operation.

Keen (*Ann. Surg.*, 30:267, 1899) and Garré (*Surg., Gynec. & Obst.*, 5:331, 1907) also reported interesting cases of partial hepatectomy for massive cancer of the liver. Abel (*Brit. J. Surg.*, 21:68, 1934), in his review included a case of his own in which he removed the entire left lobe of the liver for a primary malignant tumour; but at the time of the publication of his article the patient was rapidly going downhill and was obviously dying of recurrence.

When resection is undertaken for a localised primary carcinoma the division of the liver by means of a cautery or endothermy knife

rather than with a scalpel is to be preferred. In order to ensure a relatively bloodless field the hepatic artery and portal vein in the free edge of the gastrohepatic omentum should be temporarily compressed by the assistant's fingers or by the rubber-covered blades of a pair of small curved enterostomy forceps, lightly clamped on these important blood vessels. The tumour together with a healthy margin of hepatic tissue is then excised, and after ligaturing all sizable blood vessels the margins of the wound in the liver are approximated by the method suggested by Payr and Martina (*Arch. f. klin. Chir.*, 77:962, 1903), as represented in figure 202 (1 A and B; and 2). Broad strips of fascia are applied along the side of each margin of the wound in the liver, mattress sutures of stout catgut being passed through these and firmly tied. Van Buren Knott's well-known method (*Ann. Surg.*, 46:790, 1907) is clearly shown in the accompanying diagrams (fig. 202 [3, 4 and 5]).

Using large straight or curved Kousnetzoff needles threaded with No. 3 chromic or ribbon catgut, a series of vertical mattress sutures is introduced through the whole thickness of the liver substance on the medial and lateral aspects of the proposed lines of incision and parallel to them. These mattress sutures should be interlocked and gently tied (fig. 202 [4]).

The liver substance is then incised between the lines of sutures so as to remove a generous V-shaped wedge of liver including the tumour mass. A few large vessels presenting on the cut surface will need to be caught up with mosquito forceps and ligatured with fine silk. A series of through-and-through stitches are then passed to encircle the hæmostatic mattress sutures, and on tightening these the edges of the liver are drawn together evenly, as is well shown in the accompanying illustration (fig. 202 [5]). Drainage of the sub-hepatic space is a necessary precaution following partial hepatectomy, owing to the oozing of blood and bile which takes place from the liver wound during the first few days following operation.

Sarcoma. Primary sarcoma of the liver, which may be round-celled, spindle-celled, alveolar or angiosarcomatous, is distinctly rarer than primary carcinoma, from which clinically it cannot by any means be distinguished. There are three macroscopic types:

1. The large solitary sarcomatous mass involving one lobe, usually the right.

2. The multiple nodular growth.
3. The diffuse or infiltrating sarcoma occurring most frequently in infants.

TREATMENT. The treatment is palliative, and deep X-ray therapy may in certain instances bring temporary relief. A few cases are reported in the literature as having survived wedge-excision of the growth for a number of years.

Secondary Malignant Tumours. Secondary carcinoma of the liver is very common and occurs in from 30 per cent to 50 per cent of all patients with malignant disease. Secondary sarcoma of the liver is, of course, much rarer. The age incidence corresponds with that of malignant disease in general, *i.e.*, between 50 and 70.

The following are the methods of involvement: 1. Via the portal vein, as in carcinoma of the stomach or colon.

2. Via the hepatic artery, as in carcinoma of the cervix uteri or bronchus.

3. By direct spread from a neighbouring cancerous viscus, *e.g.*, the gall-bladder, bile ducts, pylorus, etc.

4. By surface implantation of cancer cells, as occurs in carcinomatosis peritonei.

Secondary carcinomatous growths in the liver vary considerably in size and number. There may be scattered seedlings or irregular or rounded umbilicated whitish or yellowish-white masses localised to one portion or diffused throughout the parenchyma. At times the metastasis from a cancer of the breast or from a so-called melanotic sarcoma is not nodular but rather takes the form of a diffuse infiltration, closely resembling the macroscopic appearance of cirrhosis. In many cases the clinical picture is dominated by the primary growth. As a rule, however, the liver progressively enlarges, extends downward and forward, still preserving its general form; it is woody in consistency, often nodular with umbilicated masses, but occasionally it may be smooth and even. Pain from perihepatitis is present in about half of the cases, and jaundice and ascites occur when there is obstruction within the liver or in the portal fissure.

Other features include a low-grade type of fever, loss of appetite and distaste for food, vomiting, general wasting, weakness and anæmia. In a few cases the patient remains remarkably well-nourished and is to all appearances fit and well.

TREATMENT. Palliative measures, mainly directed to the relief of pain, should be instituted. Deep X-ray therapy may be instrumental in bringing about temporary improvement in cases of lympho-sarcoma and in the more rapidly growing radio-sensitive carcinomata of the testicle.

It has been said that a *single liver metastasis* in a case of operable abdominal carcinoma may be excised with some hope of cure. This is difficult to believe. When only one small nodule is palpable at operation, several may be found at autopsy some days later, and small deep secondary growths cannot, of course, be detected by the surgeon at laparotomy. The condition is not so hopeless when the liver is involved to a limited extent by direct extension in carcinoma of the colon. Cases are on record where the affected portion of the liver was excised with the primary growth and a long period of survival obtained. (Martinez.)

CHAPTER 4

CYSTS OF THE LIVER

HYDATID CYST

Hydatid disease is rare in Great Britain and in the United States, but is common in regions of pasturage such as Australia, Iceland and Argentina. Those interested in the subject may be referred to the many articles by Dew (*Brit. Encycl. Med. Pract.*, 6:538, 1937; *Med. J. Australia*, 2:38, 1922; *Surg., Gynec. & Obst.*, 48:239, 1929; *Brit. J. Surg.*, 18:275, 1930; and *Surg., Gynec. & Obst.*, 59:321, 1934); to Duvé's *De l'echinococcose secondaire* (Paris Thesis, 628, 1901), and his other essays on hydatid disease (*Presse méd.*, 28:413, 1918; *Rev. de chir.*, 63:81, 1925; and *Australia-New Zealand, J. Surg.*, 1:99, 1934); to the papers of Fairly (*Med. J. Australia*, 1:346, 1922, and 2:27, 1932); and to the valuable contribution of Dickson Wright in *Post-Graduate Surgery*, from which the following brief remarks have been mainly abstracted.

The hydatid cyst is the intermediate cystic stage of a $\frac{1}{6}$ -inch long tapeworm of the dog (*Tænia echinococcus*). The eggs of this worm are passed in the feces of the dog and are inadvertently swallowed by the human being. Before being swallowed or shortly afterward the ovum develops into a small six-hooked (hexacanth) embryo which perforates the stomach wall and arrives in the liver through the medium of the portal vein. In some 60 per cent of cases it is arrested here. In the liver the hexacanth embryo develops into a cyst which is composed of three layers, the outer one of fibrous tissue derived from the host, and the inner two provided by the parasite. The inner of these two, the granular layer, is cellular and the outer a protective layer of hyaline tissue, known as the laminated membrane because of its structure. The cyst cavity is filled with clear fluid containing salt and a trace of protein. Small bodies form on the granular layer and these become vesicles known as brood capsules. From the lining of these small bodies of cells the heads of the future tapeworms quickly

develop. These are known as scolices. Should the development of the cyst be disturbed by trauma, portions of the wall become detached and form into two-layer daughter cysts, floating in the interior of the main cyst (endogenous daughter cysts). Sometimes the daughter cysts extrude from the main cyst (exogenous daughter cysts).

Clinical Features. There may be no clinical manifestations of the disease, and it is surprising the number of cases that remain symptomless and in which the condition is only discovered accidentally during a routine abdominal examination. If the cyst is situated in the upper portion of the liver, and it is found here in 30 per cent of all cases, it will often not be recognised until the patient is middle aged or old. Tumour formation in the epigastrium or bulging of the costal margin is frequently made out, as in 70 per cent of the cases the cyst arises from the anterior or inferior surface of the liver. The tumour is rounded, smooth and tense, and moves on respiration. There may at times be a dull ache in the hepatic region, and pain may be referred to the shoulder region, as in many other lesions of the liver. Occasionally there is considerable gastric disturbance, and nausea, anorexia, flatulence and vomiting may be troublesome features. Severe pain is experienced when the cyst ruptures into the bile passages or into the general peritoneal cavity. Pressure effects are surprisingly rare and depend upon the situation and upon the size of the cyst, but occasionally quite a large cyst may be present without producing any constitutional symptoms or any pressure effects at all. A cyst arising from the dome of the liver may remain latent for many years, but it may on the other hand, by forcing the diaphragm upward, give rise to a certain degree of dyspnoea, cause pleural effusion, or even compress the inferior vena cava.

The inferiorly located tumours may be mistaken for pancreatic cysts, for hydronephrosis, or for a benign growth or cyst of the liver. The characteristic "hydatid thrill" is, contrary to what is taught, rarely detected, but when present it is strongly suggestive of echinococcosis. The disease should be suspected when there is a cystic enlargement of the liver over a long period of time with few or no constitutional manifestations. The patient may give a tell-tale history of residence abroad in a district where the disease is prevalent. Casoni's intradermal test may be helpful in diagnosis; the complement fixation test may also be of great value. The "hydatid thrill,"

although by no means pathognomonic, is suggestive. The blood picture may reveal a marked rise in the number of eosinophiles. X-ray examination of the hepatic region may show undue elevation of the diaphragm on one side or the patchy outline of a partially calcified cyst, while clinical examination will determine the position of the cyst with great accuracy in over two-thirds of the cases.

The two chief complications of hydatid cyst are: (1) rupture; and (2) suppuration.

Intra-biliary rupture is by far the commonest complication, but intraperitoneal and intra-thoracic rupture are by no means rare events.

Treatment. The treatment is operative, and the cyst should be exposed through an incision placed directly over it. Should an abdominal incision not give direct and ready access to a posteriorly situated cyst, the surgeon should not hesitate to close the abdominal incision and make a fresh one in the back. In order to aid this a rib should be resected, pleural adhesions should be obtained by means of a seven-day gauze pack, and the cyst should then be dealt with through the obliterated phrenico-costal angle of the diaphragm.

When the cyst is simple it should be punctured, a little fluid withdrawn, and a syringe of (2 to 10 cc.) of commercial formalin injected, barbotage then being performed to mix the fluid thoroughly. After five minutes the contents of the cyst are dead and guide stitches are inserted, a small opening is made in the cyst, and a wide-bore sucker is inserted to evacuate the fluid. The cyst is then opened widely and the lining wiped out with gauze. If the cavity can be reduced by excision of some of the adventitia, this should be done. The cavity is then filled with saline solution and securely closed, after which the abdominal incision is sutured.

Drainage should be avoided if possible, being instituted only when bile or pus is present in the cyst. When used, the tube must be judiciously placed so as to afford easy drainage by means of gravity. Marsupialisation is an unwise procedure, leading to a chronic sinus which may prove a great handicap. In certain instances, however, and particularly where frank suppuration is present, the cyst will have to be anchored to the parietes and drainage provided.

When granddaughter cysts are present, special steps are taken to counteract implantation of brood capsules into the peritoneum.

Black towels are carefully placed to aid in the visualisation of any spilt hydatid structures which show up white on the towels. The cyst is then boldly opened between guide sutures with a diathermy needle, and a powerful electric wide-bore sucker is used to withdraw the contents. The clearing of the cavity is continued with gauze swabs dipped in 5 per cent formalin, and when the cavity is empty it is closed by suture, the black towels and packs are carefully removed, and the abdomen is closed without drainage unless pus or bile has been found in the cyst.

Pedunculated cysts can be removed completely, and calcified dead hydatid cysts are best left alone.

SECONDARY ECHINOCOCCOSIS OF THE ABDOMEN

This is almost invariably due to spread from a primary cyst of the liver, and dissemination follows rupture or operative interference. After the immediate effects have passed off—peritoneal and anaphylactic shock—there may be no symptoms for many years.

Operative treatment for secondary echinococcosis varies widely with the site, size and number, etc. of the cysts. A single cyst may be treated in a manner approximating to that described under general technique. On the other hand, where the peritoneum is studded with numerous small cysts, discovered maybe in the course of intervention for some other abdominal condition, the only practicable method of treatment may be to inject each cyst that is found with a few minims of commercial formalin and to leave it in situ. Nevertheless, in certain instances repeated lengthy operations may be necessary.

In intermediate cases, more or less complete removal may be possible.

To the above procedures must be added an exploration of the upper abdomen, and especially the liver, for the primary cyst, and any treatment which this may demand.

SOLITARY NON-PARASITIC CYST OF THE LIVER

Non-parasitic cysts of the liver may be single or multiple, are more common in females than in males (4:1), and may occur at any age. The majority of the reported cases have been in children. Sonntag

(*Beitr. z. klin. Chir.*, 86:327, 1913), has classified them as follows: (1) blood and degenerative cysts; (2) dermoid cysts; (3) lymphatic cysts; (4) endothelial cysts; (5) cysts due to bile duct obstruction; (6) cyst adenomata.

Multiple cysts may be limited to the liver alone, but more commonly they are associated with cysts of the kidneys, pancreas, spleen or other abdominal organs—polycystic disease. They are more common in children than in adults, and may be associated with other congenital malformations. These multiple cysts are of little interest to the surgeon.

According to Moschowitz (*Am. J. M. Sc.*, 131:674, 1906), solitary non-parasitic cysts of the liver are congenital in nature and are of biliary origin, perhaps arising from aberrant bile ducts resulting in innocent cystic adenomata. Stoesser and Wangenstein (*Am. J. Dis. Child.*, 38:241, 1929) reviewed 104 cases, Beattie and Robertson (*Lancet*, 2:674, 1932) 80 cases, and Davis (*Am. J. Surg.*, 35:590, 1937) 188 cases. Cases of unusual interest have been reported by Wikle and Charache (*Am. J. Surg.*, 31:345, 1936) and by Jennings (*Surg.*, 6:507, 1939).

In the patient on which I operated at the Southend General Hospital (1937)—a woman aged 50—the right lobe of the liver was entirely replaced by a globular cystic swelling, the surface of which was pearly white and traversed by thin-walled tortuous veins. The adherent gall-bladder was stretched out over the cyst as a long sausage-like, green rubber balloon. The contents of the cyst were aspirated, and it was found to contain as much as two pints or more of colourless, odourless, alkaline, sticky, mucinous fluid. Following aspiration, the cyst walls collapsed into a shapeless mass. The interior of the cyst was trabeculated, and was smooth and shiny, suggesting that it was lined with a well-formed layer of cubical epithelium. The walls, which were nearly 5 mms. thick, were anchored to the abdominal wound. A large-bore rubber drainage tube was inserted into its spacious cavity, and during the first week following operation there was considerable discharge of gummy fluid. This, however, soon ceased following instillations of quinine-urethane. The patient was discharged from hospital on the seventeenth day with the wound soundly healed.

The cyst is usually situated in the right lobe of the liver, although

at times it may involve the left lobe, the quadrate lobe, or even the round ligament itself. It varies considerably in size; it may be small as a pea or large as a human head. It may be wholly or partially intra-hepatic, or again it may be pedunculated.

Clinical Features. Solitary cysts of the liver apparently grow very slowly, and in most instances give rise to few if any symptoms, advice being sought on account of the presence of a painless abdominal swelling. At times, however, there may be a sudden onset of acute symptoms. This is seen when a brisk hæmorrhage occurs into the cyst, when suppuration supervenes, or when in the pedunculated variety the pedicle becomes twisted.

A correct pre-operative diagnosis of non-parasitic cysts of the liver is rarely made, the majority of the cases being diagnosed at exploratory laparotomy or at post-mortem examination. The condition, as I have stated, is usually symptomless unless complications occur or the cyst compresses some adjacent viscus such as the first portion of the duodenum or the extra-hepatic bile ducts. With compression there may be acute hepatic pain, nausea, vomiting or jaundice.

As many of these cysts arise from the anterior or inferior surface of the right lobe of the liver, clinical examination will determine the site of the tumour, while radiography may show that the tumour is part of the liver shadow. With large cysts or tumours of the liver, the colon is pushed downward and to the left of the abdomen, while in cases of a large swelling of the kidney, the colon lies over the tumour. This point can be verified by a barium enema X-ray examination of the colon.

In the case of a large pedunculated cyst of the liver, downward displacement is limited by its anchorage to the liver, but a considerable degree of lateral movement is often obtained. Pneumo-peritoneum followed by X-ray examination may be helpful, and peritoneoscopy may clinch the diagnosis. According to Schoack (quoted by Ackman and Rhea; *Brit. J. Surg.*, 18:648, 1931) the operative death-rate of non-parasitic solitary cyst of the liver is 12 per cent. Beattie and Robertson estimated the mortality at 16.1 per cent, while in Boyd's series (*Lancet*, 1:951, 1913) it was as high as 32.3 per cent.

Treatment. Excision of the cyst is the ideal treatment. This is possible when the cyst has a pedicle, and when it is situated in an

accessible position it can either be shelled out of the liver substance or be removed by wedge-resection. In the cases reported by Davis (1937) and by Jennings (1939), the broad pedicle by which the cyst was suspended from the liver was crushed, cut across distal to the clamp, and then transfixed, firmly tied and oversewn. In Wikle and Charache's case (1936) the cyst was enucleated just lateral to the gall-bladder. After the cyst had been removed, the anterior and posterior margins of the denuded surface of the liver were sutured together, leaving a right lobe fairly normal in size and appearance. There was no evidence of hæmorrhage in the cyst cavity nor was there any palpable evidence of cystic involvement of the pancreas, kidney, or other abdominal organ.

When the cyst invades the substance of the liver and is largely intra-hepatic, Wikle and Charache advise that the fluid be removed by aspiration, that the cyst wall be laid open and that as much of the wall as possible be excised. The resulting cavity is packed with gauze and marsupialised.

A great number of cases have been reported where marsupialisation and drainage have had to be carried out because complete extirpation of the cyst was impossible. In all cases, the kidneys, pancreas, and other abdominal organs should be examined for the presence of multiple cysts, and if these are found nothing surgical should be attempted.

During operation on a solitary cyst of the liver it is of the utmost importance to wall off the cyst from the rest of the abdominal cavity in order to avoid spilling the contents of a possible hydatid cyst.

CHAPTER 5

CIRRHOSIS OF THE LIVER

Portal cirrhosis is most difficult to diagnose in the pre-ascitic and even in the ascitic stage and has often been confused with polyserositis, Banti's disease, syphilitic cirrhosis, biliary cirrhosis, tuberculous peritonitis, and even cardiac insufficiency with enlarged liver and ascites. Differentiation between portal cirrhosis and secondary splenomegaly and Banti's disease is, in my opinion, quite impossible. It is in the early stages of portal cirrhosis that the best results of treatment are seen; yet, too often these cases are referred to the surgeon when the disease is very far advanced, when repeated tapplings afford little or no respite, when the heart's action is embarrassed, when renal and hepatic function are at their lowest ebb, and when the patient is cachectic, dehydrated and bled white as the result of numerous hæmatemeses. Earlier operation, when liver function is relatively unimpaired, supplemented by a proper dietary régime and medical treatment, has much to offer for these seemingly hopeless cases.

Pre-Operative Treatment. The subject of the pre-operative management of these cases has been ably reviewed by Chapman, Snell and Rowntree (*J. Am. M. Ass.*, 97:237, 1931). Fluids, meats and meat extracts should be limited to a minimum, the diet should consist chiefly of carbohydrates, and should contain a supply of essential vitamins. Diuretics, such as ammonium chloride, novasurol, salyrgan or metaphyllin, should be given, and diarrhœa be induced by prescribing calomel and saline aperients. Frequent small whole-blood transfusions are advisable, both before and after operation. Repeated tapplings should be resorted to in order to prevent any large quantities of fluid from collecting in the abdomen.

Surgical Measures.

1. *Omentopexy:*

(a) Talma-Morison operation.

- (b) Step-ladder or modified Schiassi operation.
- (c) "De-peritonisation" combined with omentopexy.
- 2. *Supplementary procedures:*
 - (a) Ruotte's venous peritoneal anastomosis.
 - (b) Paterson's operation.
 - (c) Ligature of the coronary vein combined with sclerosing injections of lithocaine (30 per cent lithium salicylate with 1 per cent tutocaine) or sodium morrhuate.
 - (e) Splenectomy.
 - (f) Ligature of the splenic artery when splenectomy is impossible.

Omentopexy. The first omentopexy for portal cirrhosis with ascites was undertaken by Van den Meulen in 1889 at the suggestion of Talma of Utrecht. The patient died of shock shortly after the operation. The first successful operation was performed by Rutherford Morison, of Newcastle, in 1895, and a report of this case appeared in print the following year (*Brit. M. J.*, 2:728, 1896). Morison's patient was a woman who lived for two years following the omentopexy and died after a second operation carried out for the cure of a ventral hernia which had developed at the site of the wound.

The object of this operation is to establish more venous anastomotic channels between the portal and systemic circulations than are provided naturally at the umbilicus, rectum and œsophagus (fig. 203).

The Talma-Morison operation is best performed under local anæsthesia. The abdomen is explored through a vertical epigastric incision, ascitic fluid is at once removed by suction, and after roughening the outer surface of the liver, the spleen, the stomach and the intestines by gauze friction to promote widespread adhesions, the omentum is sutured to the abdominal wall on either side of the abdominal incision, after which the wound is closed in the usual manner (fig. 204 [1]).

In some cases the omentum has been sutured between the layers of the abdominal wall, as first practised by Schiassi, while in others the omentum, after being drawn through a circular opening in the peritoneum and rectus muscle, is accommodated in a subcutaneous pocket. This latter method, which is termed the step-ladder operation, allows the individual layers of the abdominal wall to be sutured

together without the subsequent risk of incisional hernia (fig. 204 [3]).

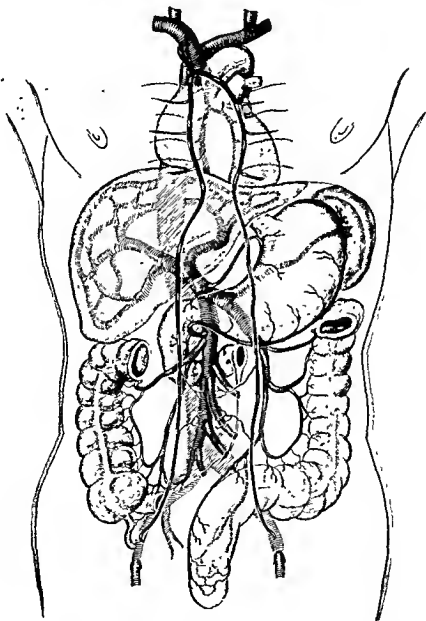


FIG. 203.—THE PORTAL SYSTEM.

When ascites is troublesome, two perforated glass bobbins may be fixed in the position shown in figure 204 (2), with the object of draining the fluid away into the layers of the abdominal wall where it is

slowly absorbed (**Paterson's operation**). This obviates the necessity for repeated tappings, while the collateral circulation is being tardily established.



FIG. 201.—OMENTOPEXY.

(1) Talma-Morison method. (2) Paterson's operation. (3) The step ladder method. (4) De-peritonisation. The peritoneum is being stripped off the anterior abdominal wall and is ready to be excised.

Omentopexy may be supplemented by implantation of the saphenous vein into the peritoneum, as proposed by Ruotte (*Lyon méd.*, 109:574, 1907). The steps of Ruotte's venous peritoneal anastomosis are as follows:

Assuming that the operation is being undertaken on the left side, a small transverse incision is made above the inguinal ligament, all the tissues being divided down to the parietal peritoneum which is then picked up with Allis forceps and incised. Another incision, commencing one inch below the inner third of the inguinal ligament and extending downward for three inches or more on the antero-medial aspect of the left thigh is made over the course of the internal saphenous vein. This vein is identified, isolated from the saphenous opening and freed downward for a distance of about 3 to $3\frac{1}{2}$ inches, its tributaries being divided close to the vein and ligatured with fine plain catgut. The lowest portion of the saphenous vein that has been freed is underrun with an aneurysm needle and ligatured with catgut. The portion of vein just proximal to this ligature is then clipped with a hæmostat and divided with a scalpel, after which it is led through a subcutaneous tunnel which has been specially made for the purpose and which extends from the top of the lower incision to the middle of the upper incision (fig. 205 [1]).

The end of the vein is then slit for a distance of $\frac{1}{4}$ inch or more and drawn through a small opening in the peritoneum, and the two portions of the divided vein are stitched with fine catgut to the parietal peritoneum in the manner depicted in figure 205 (2, 3, 4 and 5).

The parietal and femoral incisions are then closed in the usual manner.

The success of the operation, which may on occasion be spectacular, depends upon scrupulous attention to many minor but important points in technique. Thus, the portion of the saphenous vein selected must not be bruised or damaged in any way, either with the fingers or with instruments, during the process of freeing it from the thigh, as this will lead to endophlebitis with subsequent clotting and obliteration of the lumen of the vein; it must not be kinked at its point of junction with the femoral vein; there must be no undue tension or stretching of the segment of vein between its two points of attachment; chilling of the vein must be prevented by playing a



FIG. 205.—ROUTE'S OPERATION OF VENOUS PERITONEAL ANASTOMOSIS FOR ASCITES OR CHYLOUS ASCITES.

jet of warm saline solution upon it during the whole course of the operation; and, finally, the tunnel which is made in the subcutaneous tissues must be of dimensions adequate to accommodate the vein without unduly compressing it.

The operative scheme which I now adopt for cases of portal cirrhosis may be summarized as follows:

1. Long Right Paramedian Incision. This is placed one inch away from and parallel with the middle line, and extends from a point 2 inches or so below the costal margin to a point 3 inches below the umbilicus.

2. "De-peritonisation" and Omentopexy. The edges of the peritoneum on each side of the wound are picked up with a number of Kocher forceps, and after removing ascitic fluid by means of a suction tube the peritoneum is extensively stripped away from the anterior and lateral abdominal walls on each side. After retracting the muscular bellies of the rectus muscles firmly outward, a large portion of peritoneum on each side is cut away with scissors (fig. 204 [4]). As may be noted in the figure, the peritoneum is ready to be excised.

The free margin of the great omentum is then sutured to the cut edge of the parietal peritoneum with a continuous suture of silk, and when this is accomplished and the abdominal incision has been closed, it will be seen that most of the anterior surface of the great omentum lies in contact with the denuded muscles. In order to ensure a broad area of cohesion of omentum to muscle, these two structures are stitched together with a few well-placed interrupted sutures of fine silk. This manoeuvre prevents the formation of a dead space between the omentum and the anterior abdominal wall in which serous fluid may collect, thus at times interfering with the primary object of the operation.

3. Suprapubic Drainage. A long narrow fenestrated rubber tube is led down into the pelvis through a minute suprapubic stab wound, sutured to the skin incision, and connected to a suction apparatus. This tube will drain away ascitic fluid for a period extending from three to eight days, after which, owing to adhesions which surround the tube, it will cease to function, in which case it should be immediately withdrawn.

4. Supplementary Procedures. The risk of subsequent hæmatemesis may to some degree be minimised by:

(a) Ligature of the coronary vein and vasa brevia (Waltman Walters; *Proc. Staff Meet. Mayo Clinic*, 8:163, 1933); possibly combined with sclerosing injections of lithocaine or sodium morrhuate

into the prominent varicose veins at the œsophago-cardiac junction.

(b) Splenectomy or ligation of the splenic artery.

If removal of the spleen appears hazardous or is impossible owing to the presence of numerous adhesions, to its wide fixation to the diaphragm, or to the poor general condition of the patient, ligation of the splenic artery may be considered as an alternative procedure. Splenectomy reduces the portal blood flow by at least 20 per cent.

5. Closure of the Abdominal Wound. This is done by means of a series of interrupted through-and-through sutures of stainless alloy steel wire or of stout silk.

The post-operative management may be summed up in three words: glucose; diuretics; and paracentesis.

RESULTS OF OPERATIVE TREATMENT

Here are some of the published reports: Montprofit (*Traitement chirurgical de la cirrhose de la foie*, Paris, 1904) collected a series of 224 cases and claimed that 31 per cent of the patients were cured. As his follow-up reports were scanty it is probable that these figures are unduly optimistic.

W. J. Mayo (*Ann. Surg.*, 80:419, 1924) recorded 47 cases of portal cirrhosis treated by omentopexy with improvement in some instances, but he did not give late results.

Tempsky (*Beitr. z. klin. Chir.*, 136:92, 1926) reported a series of 25 cases in which there was improvement in 28 per cent. The cases were followed up for a period of eight months to twelve years.

Greenough (*Am. J. M. Sc.*, 124:979, 1902) analysed 105 cases of which only 8 per cent showed definite improvement two years after operation.

Hughson (*Arch. Surg.*, 15:418, 1927), in a frank and well-balanced article, gave the result of a study of 26 cases. He states quite emphatically that none showed any benefit from operation.

Grinnell (*Ann. Surg.*, 101:891, 1935) gave an account of the late results in 23 cases which were treated by a modified Schiassi operation. Of these cases 15 were males and 8 females. All showed gross evidence of cirrhosis of the liver and evidence of ascites at operation, and the average duration of ascites before operation was six months. A long-continued and careful follow-up showed that two (9 per cent)

were symptom-free, seven (32 per cent) were classified as improved, and thirteen (59 per cent) were reported as not improved. The operative mortality in Grinnell's series was 27 per cent. He states that the cases which did best averaged a longer duration of ascites before operation than the others. The slower the effusion into the peritoneal cavity before operation, the better the prognosis after.

Notzel (*Arch. f. klin. Chir.*, 112:153, 1919) considers that the usual mortality figures range from 20 to 30 per cent. I am in agreement with Hughson who has pointed out that the discrepancy in results is probably due to lack of adequate follow-up reports and to a failure to discriminate accurately between portal cirrhosis and other conditions such as Banti's disease and the "iced" liver of polyserositis (Pick's disease).

Taking all things into consideration it is too optimistic to assume that more than 5 per cent of these patients can be permanently cured by omentopexy and by the various supplementary procedures I have described.

PART VII

VERMIFORM APPENDIX

CHAPTER I

ACUTE APPENDICITIS

Acute appendicitis is a common, highly treacherous and lethal disease. Massed statistics show that it is yearly increasing in frequency and in virulence and that no appreciable reduction in the death-rate has been achieved during the past twenty years. It may be stated that the ætiology is still a matter of speculation, that in a number of cases the clinical features are grossly misleading and bizarre, and that success in treatment depends largely upon early diagnosis and thus upon early operation. In 1935 appendicitis caused the deaths of 1,628 males and 1,357 females in England and Wales and 16,142 persons in the U. S. A., and in 1938 there was no improvement in these figures. Acute appendicitis is approximately the eleventh leading cause of death in America, while in England it is responsible for 12 per cent of all the deaths from gastro-intestinal disease and 0.65 per cent of the total deaths registered.

Gordon Heyd (*Surg. Clin. N. Am.*, 19:260, 1939) states that the deaths which occur are largely the result of (1) purgatives; (2) delay in seeking medical advice at the onset of symptoms; (3) failure of the general practitioner to make an early diagnosis; (4) lack of confidence in the early diagnosis; (5) failure to recognise the gravity of appendicitis; (6) medical procrastination; (7) the postponement of surgical measures; (8) incorrect or faulty pre- or post-operative treatment.

Appendicitis may occur at any age. I have operated upon an infant aged six weeks and on a man aged 92 years. It is rare under the age of 5 and there is a rapid decline in the incidence after the age of 45. The peak period is in the second and third decades. It occurs most frequently therefore in the prime of life when the patient is most likely to be in a state of maximum good health.

While during recent years in England the death-rate between the ages of 5 and 45 has shown a decline, the rate at ages under 5 and over 45 has definitely increased. The mortality among males is higher

than among females, although the incidence in the two sexes is approximately the same. The death-rate is also considerably higher among the richer classes than among the poorer. In America the disease is said to be commoner in males than in females. Thus the official figures of the Bureau of the Census give the ratio as 61:39. Shepard Krech (1939), however, found that out of a total of 14,729 cases which were operated upon for acute appendicitis, 7,528 (51 per cent) were females, and this is in conformity with most of the recent statistics. There is little doubt that the incidence in females shows a definite yearly rise.

SOME ETIOLOGICAL FACTORS

Acute appendicitis is due to the infection of the walls of the appendix with micro-organisms. These micro-organisms may arrive in the appendiceal walls by one of three routes:

1. Direct spread from within, *i.e.*, from the contents of the appendix
2. Direct spread from without, *i.e.*, from an adjacent inflamed organ.
3. Via the blood stream.

What initiates the infection?

1. **Anatomical Considerations.** The appendix is a narrow tube, one end of which is blind, the other end opening into the cæcum from which it arises about one inch below the ileocæcal valve. It is the only organ in the body which has no constant anatomical position, in fact its only constant feature is its mode of origin from the large gut. It varies considerably in length, from $\frac{1}{2}$ to 11 inches, but is usually about 3 to $4\frac{1}{2}$ inches. The various positions which the appendix may be said normally to occupy have been described by Treves (*Lancet*, 1:322, 1888) in the form of a clock. Thus: 11 o'clock, paracolic (the appendix lies in the sulcus on the outer side of the cæcum); 12 o'clock, retrocæcal (the organ lies behind the cæcum and is totally or partially extraperitoneal); 2 o'clock, splenic (pre-ileal or post-ileal); 3 o'clock, promontoric (*i.e.*, the tip of the organ pointing toward the promontory of the sacrum); 4 o'clock, pelvic (here the

appendix is dipping into the pelvic cavity); and 6 o'clock, mid-inguinal (sub-cæcal).

The retrocæcal position—the safest position for the appendix to occupy—is generally considered to be the commonest. The appendix may be situated in the left lower quadrant of the abdomen in cases of transposition of the viscera, and where owing to some embryological error the cæcum fails to descend to its normal position the organ may be found in such situations as in the epigastrium, abutting against the stomach, or beneath the right lobe of the liver. Most of the examples of outstandingly unusual retrocæcal appendices are associated with maldescent of the cæcum. Complete duplication of the appendix has been described by Green (*Lancet*, 2:210, 1932), but this is an anomaly of extreme rarity.

Embryologically, the appendix is part of the cæcum of which it forms the distal end and which histologically it closely resembles with the exception that it contains an excess of lymphoid tissue in the sub-mucous layer. The mesentery of the appendix is contiguous with the lower leaf of the mesentery of the small intestine and it passes behind the terminal ileum. The appendicular artery runs in the free border of the mesentery of the appendix and is a branch of the ileocolic artery. In an appreciable number of cases there is in addition an accessory appendicular artery which is a branch of the posterior cæcal artery (fig. 206).

The veins from the appendix drain into the ileocolic vein, which in turn empties into the superior mesenteric vein. A variable number of slender lymphatic channels traverse the meso-appendix to empty into the ileocæcal glands.

Because the appendix is a blind pouch with a narrow lumen and because its contents, like those of the intestinal tract, normally teem with bacteria, the risk of the stagnation of infected contents is ever present. This risk is increased by the action of the valve of Gerlach, by the possible presence of foreign bodies, by the mobility of its position, particularly if the cæcum is also mobile, and by the fact of kinks, bands, adhesions and other causes of angulation. The muscular gaps in the wall afford a possible explanation of the apparent ease with which organisms migrate from the interior to the peritoneal cavity in acute disease. The large amount of lymphoid tissue, plus the vestigial character of the organ, predispose to infection. The circulation for all practical purposes is a terminal one, and gangrene speedily follows its interruption. The venous supply explains the possibility of complicating pylephlebitis and liver abscess.

That bacteria in the appendix may change in type and virulence is well known. But none of these considerations solves the fundamental problem of why acute appendicitis occurs.¹

2. **Race and Diet.** Acute appendicitis is especially prevalent in Europeans, Americans and Australians, while it is rare in Africans, Asiatics and Polynesians. According to Rendle Short (*Brit. J. Surg.*,



FIG. 206.—THE APPENDIX AND ITS BLOOD SUPPLY (After Max Brodel).

8:171, 1920), if the individuals from the latter races migrate to the countries where appendicitis is rife, they soon acquire the local susceptibility to the disease. Acute appendicitis is undoubtedly common among the highly civilised meat-eating races, and relatively uncommon in primitive persons and in those who habitually live on a diet rich in cellulose. Nevertheless, it occurs in breast-fed infants and in vegetarians.

¹ Boyce and McFetridge, *Internat. Surg. Digest*, 22:195, 1936 Courtesy of W. F. Prior Co.

3. **Parasites, Fæcalitbs and Foreign Bodies.** These may, and do at times, injure the mucous lining or cause obstruction of the lumen of the appendix and thus initiate an acute attack of inflammation. It should be noted, however, that in eastern countries, such as China, where worms and other intestinal parasites are very common, appendicitis is less frequent than it is in western countries. Fæcalitbs may be the result or the cause of appendicitis and are important in relation to the pathological picture when they are present; but according to Boyce and McFetridge they do not appear in more than 30 to 35 per cent of all cases. Foreign bodies, such as pins, orange pips, grape seeds, bird shot and the like, are too infrequently discovered in the appendix to be regarded as significant predisposing factors.

4. **Constipation and the Abuse of Purgatives.** Constipation may be both a cause and a result of appendicitis. It is very doubtful whether constipation *per se* has any bearing upon the problem, as many constipated individuals never develop appendicitis and many who are never constipated do. The constant use of laxatives is deleterious as free purgation alters the intestinal flora and induces a state of hyperæmia of the intestines, and hyperæmia is one of the early stages of inflammation. The pernicious practice of giving a patient with "stomach-ache" or colic liberal doses of castor oil, salts or other aperients has been universally condemned. At the onset of an acute attack of appendicitis "stomach-ache" is an almost constant symptom, in fact it may be the only symptom, and to give a purge is to lash the inflamed organ into violent peristaltic activity and thus predispose to perforation and to the lighting up of a spreading peritonitis.

5. **Trauma.** This is a possible factor in a very few cases, and trauma can only be accepted as a cause when appendicitis follows immediately or almost immediately upon the receipt of some abdominal injury.

6. **Familial Suseptibility.** Many surgeons believe that there is a familial tendency to this disease. This is accounted for by an hereditary malformation of the organ—which may be long, poorly nourished with blood, and retrocaecal or paracolic in position—which predisposes to infection. On the other hand, the incidence of a large number of cases in the same family is more readily explained by the frequency of the disease than by a familial tendency based upon anomalies of structure.

7. Is there a Relationship between Acute Appendicitis and Acute Respiratory Infections? Here there is a considerable divergence of opinion. It is said that following acute respiratory diseases, and more especially concomitantly with influenzal epidemics, the number of cases of acute appendicitis show a marked increase. Coughs and colds appear to be an impressive antecedent in many of the statistics which have been compiled. The infection may be hæmatogenous, at least it would appear to be so when an attack of acute appendicitis has followed hard upon acute tonsillitis or upon the operation for excision of septic tonsils. It is generally conceded that seasonal and climatic influences bear no constant relation to its incidence.

PATHOLOGY

The classification formerly used was as follows:

1. Acute appendicitis: (a) catarrhal; (b) suppurative; (c) gangrenous.
2. Appendicitis with perforation: (a) with local abscess; (b) with peritonitis.

This classification has, however, little to commend it except its prolonged usage. It is useless for our purpose, as it does not take into consideration the causes of appendicitis, nor the fact that many of the types are, in fact, successive stages of one process. Wilkie (*Brit. M. J.*, 2:959, 1914; and *Edinb. M. J.*, 25:308, 1920) was the first to point out that the severity of the disease is greatly modified or exaggerated according to the degree of obstruction of the lumen of the appendix which exists. If during an acute attack the appendix remains unobstructed, the disease commonly pursues a mild course; if, on the other hand, the lumen is blocked the inflammatory products remain pent up under great pressure and gangrene or perforation may speedily occur.

We now recognise two forms of acute appendicitis: (1) appendicitis *without* appendicular obstruction, and (2) appendicitis *with* appendicular obstruction.

Peritonitis, whether it be localised or generalised, is the commonest and most serious complication of appendicitis, implying that there has been considerable delay in diagnosis.

Appendicitis Without Appendicular Obstruction. The streptococcus and the colon bacillus are the two organisms mainly concerned in appendicitis. They usually work together, the infection being a mixed one. It is exceptional to obtain a pure culture of streptococci or colon bacilli in cases of acute appendicitis. Anaerobic organisms, notably *B. welchii*, are sometimes found in some of the more fulminating cases. All these organisms are derived from the contents of the cæcum, though rarely streptococci may reach the wall of the appendix via the blood stream from some distant focus of infection, *e.g.*, septic tonsils. The disease starts in the mucous membrane—catarrhal appendicitis—but seldom remains limited to this structure. It nearly always spreads outward and invades the other coats of the organ. In the initial stages of the disease the mucosa is thickened, œdematous and reddened, but later it becomes studded with dark brown hæmorrhagic infarcts, patches of grey-green gangrene or small ulcers. Eventually the whole appendix becomes swollen and turgid from a diffuse leucocytic infiltration of all its walls. When the infection reaches the serosa this becomes roughened, loses its healthy sheen and is coated with a fibrinous exudate, and local peritonitis ensues. This type of appendicitis does not usually progress acutely, but where, for instance, a fæcalith causes pressure upon the inflamed wall of the viscus a perforation leading to a localised abscess may occur.

In uncomplicated cases the acute inflammatory process may subside in a few days, but the revived organ never regains its pristine state; in fact, it becomes a "grumbler" and a menace to the patient.

It is not uncommon at an interval operation to find such appendices surrounded by numerous fine adhesions or fixed at one or more points by peritoneal bands, yet appearing to the naked eye to be healthy; dragged into some anomalous position; sharply kinked or twisted; filled with hard concretions; distended with glary mucus—mucosele; shrivelled and cord-like; thickened to the size of a finger and whitish in colour; partially stenosed; stumpy and specked, or even fragmented, *i.e.*, two or more portions of the appendix being bound together by strings of scar tissue.

Appendicitis With Appendicular Obstruction. This is the dangerous and often fatal type and resembles one variety of acute intestinal obstruction, for the appendix becomes a closed loop of bowel containing decomposing fæcal matter. The changes following the sudden

blocking of the lumen of the appendix—usually by a concretion—depend upon the amount and the character of the content distal to the obstruction; thus if infection is absent or is of a very mild nature, the appendix gradually distends with mucus to form a mucocele; if the infection is of moderate degree, the appendix becomes distended with pus—empyema, and may later become green with gangrene and rupture; while if the infection is of extreme virulence and the appendix contains a considerable amount of faecal material, gangrene and perforation may take place with great rapidity, causing a diffuse peritonitis—fulminating appendicitis.

Decomposing faecal matter leads to ever-increasing tension within the lumen, and tension and stretching interfere with the circulation through its wall; the mucous membrane, now imperfectly supplied with blood, is invaded by anaerobic organisms which multiply rapidly in the decomposing content; massive gangrene results, first of the mucous lining and later of the muscular coats, and perforation follows.*

The Effects of Perforation. The appendix may rupture at any spot, but most frequently the site of perforation is along the anti-mesenteric border. Following perforation a localised abscess may form—in the loin (appendix abscess), in the pelvis (pelvic abscess) or beneath the diaphragm (subphrenic abscess), or diffuse peritonitis may ensue. Whether the peritonitis remains localised or becomes generalised depends upon many factors which would include: (1) the age and resistance of the patient; (2) the virulence and number of the invading micro-organisms; (3) the rate at which the inflammatory condition has progressed within the appendix; (4) the position of the appendix; and (5) the nature of the treatment employed.

In the non-obstructive types of acute appendicitis the disease is comparatively limited in its course and the peritoneum has ample time to prepare for the spill of appendiceal contents. Inflammatory adhesions slowly form, gain in strength, and hem in the swollen appendix, while the great omentum becomes attracted to the seat of impending danger and wraps itself securely around the affected structure as a protective cloak.

In acute obstructive appendicitis because of the extreme rapidity of the process the peritoneum has little time to prepare a defensive

* Wilkie, *Brit. Encycl Med Pract.*, 1 729, 1936

barrage against the sudden flood of infected contents, and a diffuse plastic peritonitis results which in many instances will prove fatal from toxæmia; but in those cases where the patient's resistance is fortunately very good and where perhaps hyperperistalsis has not been induced by purgatives, a localised abscess may form in the loin, in the pelvis, or in the sub-phrenic area. The loin abscess contains a variable quantity of pus which is enclosed by the cæcum, ascending colon, omentum and small intestine on the inner side, and the peritoneum of the flank on the outer side. In children the lump tends to be medial in position, while in the aged it often abuts against the inguinal ligament and causes œdema of the overlying skin. In cases of pelvic abscess the superior wall is formed of matted coils of small intestine and omentum, the floor being represented by the pelvic peritoneum. The abscess may bulge into the rectum, vagina or bladder, or extend in an upward direction so as to be palpable above the pubis. The pelvic abscess commonly bursts through the rectum or vagina and a spontaneous cure may be effected. In certain instances it may rupture into the bladder and give rise to intractable cystitis. In some of the rapidly spreading abscesses the pus may break through its confines and track upward along the right or left paracolic gutter and thus present in the flank.

With efficient medical treatment a large number of these abscesses slowly but completely resolve, and when at a later date appendicectomy is carried out it is sometimes difficult to find any evidence, apart from a few filmy adhesions, of the havoc which has once been wrought. The danger of these abscesses is that at any time they may rupture into the peritoneal cavity and produce a spreading peritonitis. They may by binding loops of small intestine together with plastic exudate cause acute intestinal obstruction; they may be associated with pylephlebitis; or again, they may initiate a spreading thrombosis of the femoral or iliac veins.

CLINICAL FEATURES

1. **Acute Catarrhal Appendicitis.** In this disease, *i.e.*, simple inflammation of the appendix, the first symptoms are malaise, headache, anorexia, nausea, and a somewhat diffuse abdominal pain tending to localise in the epigastrium or in the region of

the umbilicus. The pain may on occasion be colicky in character, and when this is so it is often accompanied by nausea and by vomiting. The patient will often state that his symptoms are due to a liverish or bilious attack, to a chill, or to indiscretions in diet. After some hours the pain shifts to the right side and lower down in the abdomen toward the right lower quadrant. The bowels are usually constipated, at least this is so in 60 per cent of the cases. When diarrhœa is present it is a dangerous and confusing sign as the condition may be diagnosed as gastro-enteritis and treatment be instituted accordingly.

On examination the patient, although slightly flushed, does not appear to be ill. He lies quietly in bed, preferably with his right leg somewhat flexed. The tongue at first is slightly furred, so slight in fact as to be hardly noticeable; but when the disease is well established the tongue becomes thickly coated and the breath foul. It is usual to find that the temperature and pulse-rate are both above the normal. The temperature may be as high as 99° or 100°F., but rarely reaches higher than 101°F. The pulse is quickened, 80 to 100, and full, but this is difficult to evaluate unless the normal pulse-rate of the individual is known. A steadily rising pulse-rate is always significant and is of serious import. Inspection of the abdomen will reveal nothing amiss except that there may perhaps be on deep respiration some limitation of movement in the lower half. Auscultation will reveal normal peristaltic sounds, unless a purgative has been given, in which case loud splashing and gurgling noises will indicate that the gut is vigorously contracting.

The whole abdomen should be systematically and gently palpated with the warmed hand to detect the area of maximum tenderness—the position of the appendix. The extent of this tenderness depends not only upon the position of the appendix but also upon the extent of the pathological process. Thus in early cases of acute catarrhal appendicitis the tenderness on deep palpation may be definitely circumscribed and the patient may accurately indicate the site of the appendix by placing the tip of his index finger upon the most sensitive spot in his abdomen—the pointing sign. The site of tenderness will coincide with McBurney's point only when the appendix lies immediately beneath it, and it is surprising how often this is not the case. It is not until the inflammation reaches the anterior ab-

dominal wall that local signs are obvious; muscular rigidity is therefore a comparatively late sign.

The tone of both rectus muscles should be compared and the lateral abdominal muscles carefully palpated to detect any guarding. Generalised rigidity spells peritonitis. Rigidity is always less marked in obese patients, in the aged, in infants, and in emaciated individuals with attenuated abdominal muscles. Voluntary defensive rigidity must be distinguished from true rigidity, and in children this differentiation may be a matter of considerable difficulty.

When the unperforated appendix is hanging over the brim of the pelvis or is lying wholly within the pelvis, abdominal rigidity and tenderness may be completely absent. On rectal examination, however, the swollen inflamed organ may be felt or definite tenderness be elicited on the right side or in the recto-vesical pouch.

A rectal examination should be routinely performed upon all patients suspected of appendicitis or of other abdominal disease. It should be carried out whenever the diagnosis is obvious, and even more particularly when it is dubious.

In the past too much stress has been laid upon the signs in the right iliac fossa and too little upon the signs which result from the irritation of adjacent organs and structures. Thus, irritation of the rectum—diarrhoea; irritation of the bladder—pain and frequency of micturition; irritation of the mesentery of the terminal ileum—pain after partaking of food; irritation of the right ureter—hæmaturia.

In cases of doubt where the symptoms are somewhat indefinite, the signs vague, and rectal examination is negative, a leucocyte count may prove of value. A moderate polymorphonuclear leucocytosis, say of 10,000 to 12,000, may clinch a diagnosis of appendicitis, and at the same time rule out the possibility of influenza, of enteric fever and paratyphoid.

Differential Diagnosis. The diseases most frequently mistaken for acute catarrhal appendicitis are: (1) acute mesenteric lymphadenitis; (2) acute pyelitis; (3) acute salpingitis; (4) acute cholecystitis; (5) "gastric influenza;" (6) right basal pneumonia and pleurisy; (7) regional enteritis (see page 1078).

The symptoms and clinical findings in cases of *acute mesenteric lymphadenitis* are extremely variable. There is, however, some tenderness and rigidity just below and to the right of the umbilicus. The

physical signs are not progressive, and on occasion enlarged abdominal lymph nodes may be palpated in both lower quadrants. Foster (*Arch. Surg.*, 38:131, 1939) states with authority that the danger of leaving an inflamed appendix in the abdomen is too great to allow of postponement of exploratory laparotomy when a diagnosis of acute mesenteric lymphadenitis has been made or is suspected. The removal of the appendix in most cases of acute mesenteric lymphadenitis is sufficient to warrant a good recovery.

Acute pyelitis may simulate appendicitis, but the initial pain is never around the umbilicus or in the epigastrium. The temperature is higher—103° to 104° F.—and the urine contains *B. coli* and pus cells.

In *acute salpingitis* there is often a history of leucorrhœa and dysmenorrhœa and of a burning sensation on micturition, while on physical examination there is tenderness low down on both sides of the hypogastrium, and on pelvic examination there is often evidence of acute tubo-ovarian disease. A smear from the cervix uteri may help to settle the diagnosis which at times may present unusual difficulties.

In *acute cholecystitis* the temperature is usually high, 101° to 103°F. The site of maximum tenderness is below the right costal margin. There may be (though this is not invariable) a tinge of jaundice, and a mass or a pyriform tumour may be made out which is continuous with the edge of the liver. It should be remembered that in acute cholecystitis the cæcum is often distended with gas, and pressure over the gut may elicit some tenderness. The clinical manifestations of a high-lying inflamed retrocæcal appendix closely simulate those of acute gall-bladder disease, and in cases of doubt the wisest plan is to explore the abdomen.

A diagnosis of "gastric influenza" accounts for many deaths in cases of acute appendicitis, especially in children.

In the differential diagnosis, *right basal pneumonia and pleurisy* are typical examples of occasional difficulty. The differentiation is rendered more confusing by the fact that appendicitis may begin with or occur in the course of an acute respiratory infection. It should be remembered that in cases of pneumonia the patient looks ill, the alae nasi are constantly working, the respiratory excursions are quickened, the temperature is considerably raised, the relation

of the pulse-rate to the respiration-rate—which is usually 4:1—may become 4:2 or even closer, the white cell count shows a marked leucocytosis, and the right-sided abdominal rigidity is inconstant and voluntary. In cases of doubt Barrington-Ward advises a delay of one or more hours, so as to allow the physical signs in the chest to be recognisable.

2. **Acute Obstructive Appendicitis.** The onset is sudden. The patient is seized with an acute attack of colicky abdominal pain which frequently starts during the night or in the early hours of the morning. The colic is severe in character and the patient at the height of each seizure is doubled up in agony and vomits repeatedly. After a while the spasm subsides, but a dull ache remains and localises mainly around the umbilicus. The griping returns once more and the act of vomiting and constant retching exhausts the patient who now begins to feel anxious about his condition.

If an examination is conducted during the first few hours after the onset, constitutional disturbances will be absent or slight, the temperature and pulse will be found to be normal, and physical signs may be absent. The tongue is not furred and the abdomen moves easily and freely on respiration. In some cases there is a slight degree of hyperæsthesia in Sherren's triangle, and some tenderness on deep palpation may be elicited in the right iliac fossa, especially when the appendix is lying immediately beneath the abdominal wall. If it were not for the history of intermittent cramp-like abdominal pain and vomiting, and perhaps a suspicion of tenderness in the right lower quadrant of the abdomen, a mild gastro-intestinal upset, such as may be caused by eating unripe fruit, might be diagnosed. Yet, as Wilkie has emphasised, every hour counts in this type of appendicitis, and it is the surgeon's duty to act promptly and courageously and to excise the tense distended appendix before perforation supervenes.

Differential Diagnosis. Acute obstructive appendicitis has to be distinguished from: (1) renal colic; (2) biliary colic; (3) intestinal colic; (4) acute intestinal obstruction; (5) lead poisoning; (6) mesenteric embolism or thrombosis; and (7) twisted ovarian cyst.

In *renal colic* the pain may be intense and collapse profound. There may be some rigidity and tenderness over the affected kidney, extending downward toward the right iliac fossa, but the rigidity

tends to be intermittent in nature. There is considerable restlessness, but the movements of the body do not aggravate the pain, but rather tend to afford relief. The radiation of the pain downward into the groin or the loin may be significant, as may be a previous history of hæmaturia or other urinary trouble. In both renal and appendicular colic the testicle on the right side is often retracted.

In *biliary colic* there may be a past history of gall-bladder disease. The pain, which is localised to the gall-bladder, may be acute and prostrating, colicky in character, but continuous between the sharp bouts. It is mainly localised to the right hypochondrium, but radiates to the back between the shoulder blades and upward into the right scapular region. During an attack of biliary colic the patient writhes in agony, restlessness is very marked, and retching or the vomiting of frothy bile may be incessant. On examination there are usually some tenderness and rigidity which are localised to the upper right quadrant of the abdomen, *i.e.*, in an area where it is most uncommon for the appendix to lie.

Intestinal colic is sometimes caused by catarrhal enteritis due to irritation from unsuitable food, ptomaine poisoning, purgatives of various sorts, or the toxins of some fevers. It is seen in a more severe degree in enterospasm and in cases of organic obstruction of the intestine. The pain, like that of acute obstructive appendicitis, is griping in nature, is referred to the umbilical region or to the epigastrium, and is accompanied sometimes by local areas of distension where gurgling bowel sounds may be heard. Vomiting occurs, and the writhing movements of the intestines may occasionally be seen through the anterior abdominal wall. Colic due to enteritis is usually followed by diarrhœa, while colic due to organic obstruction at a later stage gives place to the manifestations of acute intestinal obstruction. Zachary Cope has taught, with good effect, that when pain assumed to be due to intestinal colic persists for more than three or four hours, the condition is generally one calling for surgical intervention.

In the early stages of *acute small gut obstruction* the abdominal wall is flaccid. As the obstruction progresses there may be distension varying with the site of the obstructing agent. From the very first, vomiting is a most characteristic feature. The alterations in the character of the vomited material—stomach contents, bile, dark fluid and

feculent material—at once suggests that an unrelieved obstruction is present.

Lead colic differs from the above forms of colic in that there is generalised abdominal rigidity and tenderness. The pain associated with lead poisoning is definitely colicky in nature but not continuous. There may be a history of intermittent intestinal colic associated with a severe form of constipation. The patient may admit that his work brings him into contact with lead, and the blue line of lead poisoning may be evident upon the gums. Even after the patient has not worked with lead for a very long time, this indication will persist. If, when the blood is examined, punctate basophilia is found in addition to secondary anæmia, this will constitute valuable corroborative evidence, as it is present only during the acute stages of lead poisoning.

In *mesenteric embolism or thrombosis* there is violent abdominal pain which is followed in a short time by prostration. When the bowels are evacuated blood will often be found to be present in the stools, or these may be almost wholly composed of blood. The abdominal pain is constant and fairly diffuse, but at intervals it becomes colicky in nature. A deathly pallor accompanies other signs and symptoms found in a severe internal hæmorrhage. The pulse will be quick, steadily rising, and weak. The temperature is sub-normal and the respirations are shallow. Collapse, which is present from the first, does not decrease but rather increases with the passage of time. Through the tender and slightly rigid abdominal muscles an ill-defined diffuse tumour—clotted blood filling the gut—may be felt. There may be a history of cardiovascular disease or of previous embolism elsewhere.

It is unlikely that a *twisted ovarian cyst* will cause any difficulty in diagnosis, but in some of the smaller cysts the origin of the symptoms may be in doubt until a pelvic examination has been carried out.

3. **Appendicitis with Local Peritonitis.** Here the diagnosis is obvious. The patient is flushed, the tongue coated, the temperature and pulse are both elevated, and the physical signs are those of a localised collection of pus in the abdominal or pelvic cavity. There will be tenderness and rigidity in the right iliac fossa when the perforated appendix occupies this position; also when it is placed behind the colon or its tip points upward toward the kidney, the flank muscles

will be on guard; while when it lies in the pelvis, palpation of the abdomen will reveal little amiss except some slight tenderness low down in the hypogastrium.

In cases of pelvic appendicitis associated with a spreading pelvic peritonitis or localised abscess, mucous diarrhoea due to irritation of the mucous membrane of the rectum, and frequency of micturition due to congestion of the wall of the bladder are often present. A rectal or vaginal examination will usually make the diagnosis clear to the physician.

In those instances where the appendix occupies a purely abdominal position and is not covered by intestine, owing to the marked resistance of the abdominal muscles, it is often difficult to determine on palpation whether a circumscribed walled-in abscess or a spreading peritonitis is present. Sometimes the perforated appendix becomes wrapped in omentum and forms a palpable and movable mass. In the majority of cases of appendiceal abscess the mass which forms becomes fixed to the posterior or more rarely to the anterior abdominal wall. This may on occasion superficially resemble a cancer of the cæcum. In the latter disease, however, the tumour is usually freely movable until it has reached an advanced stage, and it is moreover comparatively painless on deep palpation. Where doubt exists, a fluoroscopic examination of the colon after the administration of a barium enema will help to settle the diagnosis. Sometimes a hæmatoma or abscess of the anterior abdominal wall or suppurating deep iliac glands may closely simulate an appendiceal abscess.

4. **Appendicitis with Spreading or Diffuse Peritonitis.** It is always extremely difficult to determine the cause of diffuse peritonitis, especially when the patient is seen some days after the onset of the disease. A carefully taken history of the case combined with searching investigations will help to exclude such common causes as perforated peptic ulcer, perforated diverticulitis and gangrenous cholecystitis, and even rarer causes such as pneumococcal peritonitis. The surgeon should remember that in cases of perforated duodenal ulcer the irritating chyme may pool in the right iliac fossa before flooding the pelvis and the general peritoneal cavity. In early cases therefore the maximum site of tenderness and muscular guarding is found in the right side of the abdomen and more especially in the right iliac fossa.

Symptoms and Signs. The symptoms and signs are characteristic. The patient looks gravely ill and his face is pale and drawn. The pulse is rapid and small, the temperature may or may not be raised, the respirations are quickened and shallow, and the abdomen is distended, tympanitic, tender and rigid, more so in the lower than in the upper half. Pain tends to diminish in severity, while vomiting becomes more frequent. Rectal examination will reveal that the pelvic peritoneum is extremely tender to the searching finger, and on occasion matted coils of blown out intestines may be identified. On abdominal auscultation a few peristaltic sounds may be heard, but at a later stage there is a death-like silence.

Diagnosis. In the diagnosis of acute appendicitis clinical methods stand supreme, and it is a tribute to these methods that in over 90 per cent of cases the findings at operation prove the diagnosis to have been correct. It is true that laboratory methods, and in particular examination of the blood (differential white cell count) and bacteriological investigation of the urine, play a part in the final elucidation of the cause of the lesion; but it is often a subsidiary one, and in equivocal cases the aid of the radiologist may be essential. Nevertheless, in the majority of cases a decision is reached and treatment is adopted without the help of what may be termed ancillary methods.

Touroff (*Surg. Clin. N. Am.*, 19:287, 1939) has cogently stressed the claims of peritoneal aspiration, first proposed by Solomon in 1906, as an aid to diagnosis in cases of acute appendicitis with or without peritonitis. He is most emphatic that a carefully elicited history and thorough physical examination still remain the foundation of diagnosis and that peritoneal aspiration serves not as a substitute but as an adjuvant to be employed in cases in which the *diagnosis remains obscure*.

The site of election for aspiration is a point 1 inch below and 1 inch to the right or left of the umbilicus. This area is anaesthetised with a few cubic centimetres of 1 per cent novocaine, after which an 18-gauge lumbar puncture needle with its stylet in place is introduced through the wheal into the abdominal wall in an inward and slightly upward direction. The needle, with its bevelled edge facing downward, is advanced a little, and as the point enters the peritoneal cavity a distinct "give" is felt, similar to that experienced when the theca is pierced during lumbar puncture. The needle is then steadied

by the fingers of the left hand, the stilette is withdrawn, a 10 cc. Record syringe is attached, and suction is made while the point of the needle is moved gently and cautiously in various directions. A few drops of the aspirated fluid are squirted on to a glass slide and fixed and stained by Gram's method. Touroff states that those surgeons who are unfamiliar with the technique of peritoneal aspiration object to it on the ground that there is a real danger of puncturing the intestine; but if the procedure is carried out with due care this accident should not occur owing to the tendency of the intestinal loops to glide ahead of the needle as it is advanced within the peritoneal cavity. The method is obviously contra-indicated in cases of sub-acute or chronic peritonitis when matting and gluing of the intestines to the abdominal wall are so prone to occur.

In a large number of cases no organisms are seen on direct smear, but this should not influence the surgeon against operation if the clinical manifestations support or at least strongly suggest a diagnosis of acute appendicitis. If on microscopical examination the smear shows polymorphonuclear leucocytes plus *B. coli* plus streptococci, or *B. coli* alone, the diagnosis of bacterial peritonitis secondary to acute appendicitis would appear to be well established. In cases of frank clinical peritonitis a smear containing polymorphonuclear leucocytes and a large number of streptococci alone indicates primary streptococcal peritonitis, especially if a large quantity of blood-stained fluid is withdrawn on aspiration. On rare occasions pus cells plus streptococci alone are found in cases of appendicular origin; but in such instances the fluid withdrawn is scanty in amount and the leucocytes plus pneumococci are characteristic of pneumococcal peritonitis while a smear containing polymorphonuclear leucocytes plus Gram-negative diplococci, especially if intra-cellular, is typical of a spreading gonococcal peritonitis.

5. **Atypical Acute Appendicitis.** There are a large number of atypical cases.

(a) *Acute Appendicitis with Diarrhœa.* In early cases of acute appendicitis, although constipation is a common feature, diarrhœa may be the first symptom. If diarrhœa is accompanied by slight but persistent tenderness and a suspicion of rigidity in the right iliac fossa, and if in addition on rectal examination considerable pain is experienced, it is wiser to explore the appendix than to temporise.

(b) *Early Acute Appendicitis with Hyperpyrexia.* In some cases of acute appendicitis the temperature may remain normal or sub-normal for the first twenty-four hours or so; but it is more usual to observe a slight rise of temperature, say 99° to 100°F. During this period the temperature elevation rarely exceeds 101°F. A temperature over 102°F. during the first few hours of an attack of abdominal illness at once suggests a diagnosis of pneumonia or of pyelitis; nevertheless, in some fulminating cases of acute appendicitis the disease may be ushered in with a very high temperature. Acute appendicitis cannot be excluded because the temperature is too high. If the history and clinical picture support a diagnosis of acute appendicitis the organ should be removed immediately.

(c) *Acute Appendicitis without Rigidity of the Abdominal Muscles.* Abdominal rigidity may be absent:

1. When the patient is examined very early in the course of the disease, i.e., before there has been any irritation of the parietal peritoneum.

2. When the appendix lies deeply placed in the pelvis. Here a rectal examination will yield valuable information.

3. When the appendix is situated behind the cæcum and colon and is, to all intents and purposes, retroperitoneal. An inflamed appendix which is covered by the colon bears no relation to the anterior parietal peritoneum and thus local abdominal tenderness and rigidity may be absent. It cannot be too strongly emphasised that it is not until the inflammatory process reaches the anterior abdominal wall that local signs are obvious and by that time the peritoneal cavity or the loose cellular tissues of the right lumbar region may be seriously infected.

4. Shortly after the perforation of a gangrenous obstructed appendix, when pain so often ceases abruptly, when hyperæsthesia disappears and when the patient states that he is feeling very much better. On examination there is little or no tenderness of the right iliac fossa and the feeble spasm of the guarding muscles may not be appreciated by inexperienced fingers. The temperature is often normal but the pulse-rate gradually rises, foreboding a spreading peritonitis.

(d) *Acute Appendicitis in Children and in the Aged.* In children and in aged patients the history taken is often inaccurate, being difficult to elicit. The symptoms at times are confusing, and the signs

are hard to interpret. In both these extremes of life appendicitis nearly always begins as an obstruction. The onset is sudden, there are repeated attacks of cramp-like abdominal pains often followed by vomiting, a dull ache persists and centres round the umbilicus, the temperature and pulse are normal, and on physical examination nothing abnormal is discovered. As the hours pass the systemic signs of toxæmia may appear, and when the peritoneum becomes involved, pain, tenderness and rigidity are manifest in the right lower quadrant of the abdomen. In such patients, possessing as they do feeble powers of resistance, the surgeon must not wait for obvious signs such as marked abdominal rigidity, since by doing so he is gambling with life. If it is *probable* (and the appreciation of probability is the very essence of early diagnosis) that a child has acute appendicitis, an urgent operation should always be advised. Acute appendicitis accounts for more than 50 per cent of the acute abdominal emergencies in children.

CHAPTER 2

TREATMENT OF ACUTE APPENDICITIS

In the early case we must be able to give a sound reason why we should not operate; in the late case an equally sound reason why we should (Wilkie).

The medical profession owes a great debt of gratitude to Fitz. Murphy, Treves, Kelly and Ochsner for their pioneer work in connection with acute appendicitis. The removal of the appendix in the quiescent period was advocated by Sir Frederick Treves in 1887 (*Tr. Roy. Med. Chir. Soc.*, 71:165, 1888). To-day appendicectomy is by far the commonest of all abdominal operations. The treatment of acute appendicitis is appendicectomy. All surgeons are agreed that during the first forty-eight hours following the onset of an attack the appendix must be removed immediately, provided there are no obvious contra-indications. The sooner the diagnosis is made and the sooner the inflamed appendix is excised, the better the prognosis.

PRE-OPERATIVE PREPARATION

On admission to hospital the patient is immediately examined, placed in a semi-sitting position, and a pre-anæsthetic, such as omnopon, gr. 1/3 and scopolamine gr. 1/150, is given to allay pain and anxiety. No fluids are permitted by mouth, and enemata are definitely contra-indicated. The abdomen is prepared in the usual manner, and if the patient cannot pass water he is catheterised. If toxæmia or dehydration is present, saline solution with 5 per cent glucose is introduced into the circulation by the intravenous route. As much as one or two hours may profitably be spent in improving the patient's condition before operation is undertaken.

CHOICE OF INCISION

Experience should enable the surgeon to determine before operation the position and the pathological changes in the appendix and

in its surroundings. When the patient is fully anæsthetised, the surgeon should once again systematically palpate the abdomen in an endeavour to locate the exact position of the appendix. A circumscribed lump may be felt; a diffuse thickening may be made out; there may be a small area of metallic hardness in the abdominal wall; or a movable tumour may be identified. It is important to know where the appendix is situated, as the incision must, where possible, be placed directly over it. Access must be direct, the incision must be carefully planned, and exposure must be adequate without being excessive.

There is no one special incision for appendicectomy (see fig. 8). If the appendix lies immediately beneath the abdominal wall in the right iliac fossa, McBurney's gridiron incision is clearly the one of choice. This incision may be extended downward and inward through the sheath of the rectus muscle (Weir) and upward by cutting across the fibres of the internal oblique and transversalis muscles. The gridiron incision has been employed in over 80 per cent of my cases. Rutherford Morison's or more correctly Kocher's, modification of the McBurney incision, in which all the muscles are divided transversely or obliquely, affords an excellent approach to an appendix lying far out in the loin above the level of the anterior superior iliac spine, and is sometimes used to gain access to a hidden, adherent, retrocæcal appendix.

When it is thought that the appendix is central in position or is lying in the pelvic cavity, a median or paramedian incision should be chosen.

Battle's para-rectal incision is preferred by some surgeons, but for the reasons already discussed (page 7) I rarely find it necessary to employ it. All bleeding points in the wound should be clipped and tied with fine plain catgut before the peritoneum is exposed. Tetracloths are fixed to the skin margins, and the fatty layer of the abdominal wall is protected with cellophane squares before the peritoneum is cautiously opened.

THE REMOVAL OF THE INFLAMED APPENDIX

The moment the peritoneum is incised, retractors are inserted and the margins of the wound are separated and elevated to permit of

easy inspection of the structures which are involved in the inflammatory process. The surrounding coils of small intestine are gently walled off with long strips of gauze. The cæcum is picked up with the fingers or with a pair of smooth dissecting forceps, the blades of which may with advantage be covered with rubber tubing, and is slowly and carefully withdrawn through the incision. The index finger of the right hand may be used to lift the appendix and coax it on to the surface, but whenever this manœuvre is necessary it must be performed with the greatest gentleness.

Bruce (*Lancet*, 1:1247, 1939) rightly affirms that nothing varies so much in surgical clinics as the surgeons' ideas of gentleness. Are we as gentle as we think we are? I cannot conceive of anything more dangerous than the so-called "hooking out" or blind dissection with the fingers of a friable gangrenous appendix, more especially when it happens to be fixed to the lateral wall of the pelvis or to be embedded in coils of small intestine. In such cases the appendix is not uncommonly ruptured or torn in half, the retroperitoneal tissues are lacerated and suffused with blood, hæmostasis is tedious, difficult and imperfect, and post-operative complications such as spreading peritonitis, localised abscess, faecal fistula and paralytic ileus are prone to occur as the result of such methods.

The appendix must be removed under direct vision and all intra-abdominal manipulations must be reduced to a minimum. The appendix itself should be handled as little as possible, and on many occasions it can be removed without even touching it with the fingers. The soft plastic lymph which binds the organ down to nearby structures can often be atraumatically separated by dissection with a small swab which is held in the points of a long slender hæmostat or with blunt dissecting forceps. Bands are clipped and snipped with scissors, adhesions are divided and tied, and the appendix when free and mobile can be lifted on to the external protective waterproof sheets. The cæcum, partially covered by a swab, should be steadied by the assistant, and no intestines should be allowed to protrude or prolapse through the wound into the operative field; in fact, if the packing off has been well done all that can be seen at this stage of the operation is the cæcum, the appendix, and the last inch or so of the ileum.

Morant Baker forceps are applied around the appendix in such

a manner as to encircle the organ and yet not inflict any damage upon it (fig. 207). These forceps are excellent tractors and do not tear through the meso-appendix. With the appendix elevated and with the meso-appendix well defined and taut, this latter structure is ligatured and divided. If the meso-appendix is long, thin and rather redundant, it may be simply transfixed and ligatured with a strand of No. 0 or No. 1 twenty-day chromic catgut, after which it is severed (close to the appendix) from the tip to the base of the organ. The ends of the ligature are left long and caught with a pair of artery forceps (fig. 207 [2]). It is more usual, however, to divide the meso-appendix by clipping, and then by snipping with scissors, section by section until the base of the appendix is reached. The individual sections of the meso-appendix embraced by the hæmostats are then tied off seriatim and the ligatures are carefully cut short, but not too short.

When the mesentery of the appendix is fatty, œdematous or gangrenous, the ligatures have to be applied with special care as they are so likely to cut through this friable and buttery structure. If the ligatures persistently cut through, the resultant raw surface should be cautiously oversewn with a few well-placed interrupted sutures. If this fails to control hæmorrhage the oozing area should be packed with a strip of gauze and additional drainage provided with a soft rubber tube.

It is always a wise precaution to insert a single interrupted suture close to the base of the appendix at its mesenteric border in order to secure the intra-mural branch of the posterior cæcal artery or of the appendicular artery (Selig).

The appendix is now free and is drawn firmly upward and its base ligatured with a strand of No. 0 or No. 1 chromic catgut, the ends of which are cut short. A purse-string suture (No. 0 twenty-day chromic catgut or fine silk mounted on an eyeless needle) is next inserted to encircle the caput cæci, about one-third to half an inch from the appendix. This suture passes through the seromuscular coat, especially at the longitudinal bands, and great care is taken to avoid puncturing the gut.

The ends of the purse-string suture are laid aside while a hæmostat is applied to the appendix about $\frac{1}{4}$ -inch away from its ligatured base. The appendix is divided with a knife which has been dipped

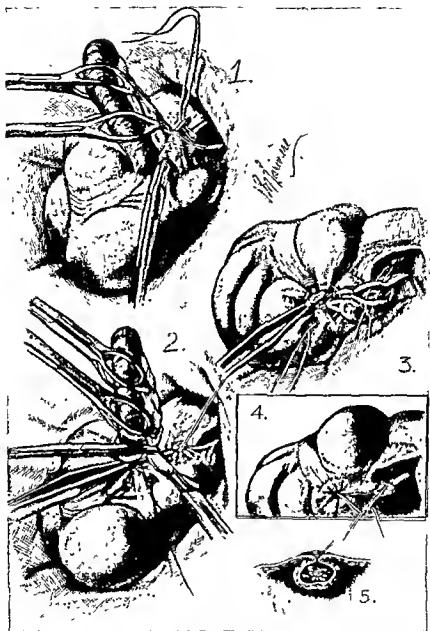


FIG. 207.—APPENDICECTOMY.

Intra mural implantation of the appendix stump.

in pure carbolic acid or with a cautery point. The stump is meantime steadied with small dissecting forceps while its surface is wiped with a swab and touched with a cautery or a drop of pure carbolic on the end of a probe, and the stump is invaginated as the ends of the purse-

string suture are pulled taut and tied (fig. 207 [3]). The stump is thus buried in a small blind pocket in the cæcal wall—intra-mural implantation (fig. 207 [5]). A few interrupted mattress sutures, another purse-string suture or a letter N or Z stitch may be inserted if it is thought advisable to secure an even further inversion of the stump into the pouch.

These suture ends or the ends of the original purse-string suture may be left long to tack down the meso-appendix (when it is bulky and freely mobile) to the invaginated area, or by another method the long end of the ligature which has been applied to the meso-appendix and the ends of the purse-string suture may be knotted together, thus covering over any raw edge of peritoneum (fig. 207 [4]).

If the meso-appendix is stumpy, œdematous or unduly friable, or if it has been necessary to tie off the meso-appendix in sections, this method of obliterating the raw edges of the peritoneum should not be adopted, as the ligatures on the meso-appendix are likely to pull out. It is far better in such cases to re-peritonise the raw surface with a few interrupted sutures, care being taken in inserting the small atraumatic needle not to puncture any blood vessel, as if this is done a troublesome and rapidly diffusing hæmatoma will form and occasion anxiety or even alarm (fig. 207 [3]).

When the cæcal wall is sodden with œdema, the purse-string suture is omitted. In these cases a strong ligature is applied to the base of the appendix and the appendix cut across one-quarter to one-third of an inch distal to the ligature. The pouting mucous membrane is cauterised, and the ends of the ligature which has been applied to the base of the appendix may with advantage be left long in order to anchor a portion of the meso-appendix over the vulnerable spot (fig. 208 [1]).

It is tempting to draw the handy, so-called "bloodless fold of Treves" and to stitch it or tie it over the appendix stump; to do so, however, may sometimes lead to angulation and subsequent obstruction of the last inch or so of the ileum. This fold is therefore better left alone.

Two methods of treating the appendix stump have now been described: (1) simple ligature of the stump; and (2) ligation and inversion of the stump. Ligature and inversion of the stump is the method

favoured by the majority of surgeons (70 per cent in England). In my opinion, simple ligation of the stump is only indicated when the



FIG. 208.—APPENDICECTOMY.

Two simple methods of dealing with the stump of the appendix.

cæcal wall is stiffened with inflammation. Any sutures inserted under these circumstances would surely tear out when tied.

There are two other methods of treating the appendix stump: (1) inversion without ligation of the stump; and (2) excision of the

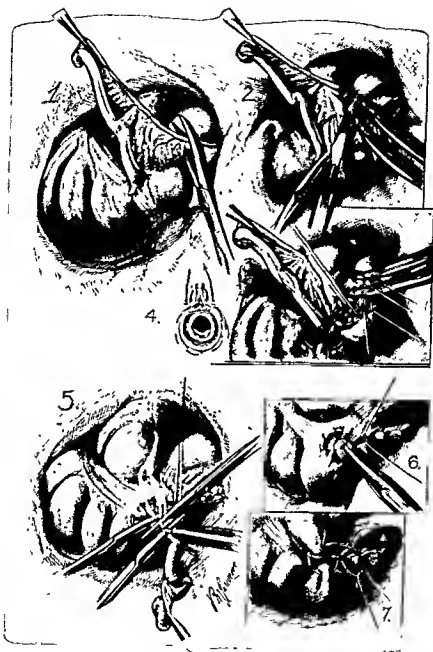


FIG. 209.—APPENDICECTOMY.

Intra-luminal invagination of the stump. (After Ochsner and Lilly.)

appendix and portion of the cæcal wall with inversion. Ochsner and Lilly (*Surg.*, 2:532, 1937) strongly recommend the adoption of inversion without ligation of the stump—intra-luminal implantation. The

method advocated by them and practised by some surgeons is clearly illustrated in figure 209 (1-7), but so far as I am aware no trouble has ever arisen from the use of the inverted stump method in any of my cases, and I therefore see no reason for abandoning this well-tried and generally approved technique.

Excision of the appendix and a portion of the cæcal wall with inversion would appear to be indicated when the appendix, its base, and a surrounding portion of the caput cæci are frankly gangrenous. The gangrenous structures are excised and the defect in the cæcum is sutured and then securely invaginated.

This operation is rarely performed, as it is nearly always possible to turn the gangrenous area into the bowel after the appendix has been excised.

RETROGRADE APPENDICECTOMY

This operation is indicated when the base of the appendix can be readily seen and isolated while the remainder of the organ is firmly bound down in the retrocæcal fossa or in some other hidden retreat. It is of the utmost importance to have the whole length of the appendix in view during the operation, otherwise the tip of the appendix may be overlooked; also, when the organ has been excised it should be carefully examined to make sure that it is intact. The base of the appendix is cautiously freed by a little blunt dissection, until the whole circumference of the organ near the cæco-appendiceal junction can be visualised. A dissector or a probe is passed through the meso-appendix and a pair of Morant Baker forceps is applied so that the jaws surround the appendix and at the same time obtain a firm hold on the meso-appendix (fig. 210 [1]). When traction is made on the Morant Baker forceps the first half inch or so of the appendix can be completely freed, and it is then a simple matter to ligature the base of the appendix, insert a purse-string suture, clamp the organ about one-third of an inch away from its ligatured base, divide the appendix with a knife, wipe or touch the cut surface of the appendix with pure carbolic acid, invaginate the stump, tie the purse-string suture firmly and then proceed to divide the remainder of the meso-appendix and clip, cut and tie small portions of it at a



FIG. 210—RETROGRADE APPENDICECTOMY.

time until the entire meso-appendix is divided and the organ is removed (fig. 210 [2] and [3]).

The numerous ligatured points in the meso-appendix are inverted with interrupted mattress sutures, and the cæcum is then returned to the abdomen.

DRAINAGE OF THE PERITONEAL CAVITY

Drainage is unnecessary, and possibly harmful, when the appendix has been removed intact. The clear odourless peritoneal exudate which is seen in many cases of unperforated appendicitis is protective in nature and should not be aspirated, mopped up or drained away.

Drainage is required:

1. When a localised collection of evil-smelling pus is found around the perforated appendix. Here a drainage tube is inserted through the wound down to the cæcum.
2. In the case of a walled-off abscess (page 892).
3. In general and pelvic peritonitis. Here the drainage tube should, if possible, be introduced through a supra-pubic stab wound.
4. When there has been suppuration in the retrocæcal space. Here, a strip of corrugated rubber sheeting is led to the infected area through a stab incision in the flank.

DRAINAGE OF THE WOUND

If the appendix has ruptured during its removal, if there has been a considerable amount of peritoneal exudate, if the appendix, although unperforated, is frankly gangrenous, if the patient is fat and if Morison's incision has been employed, it is always a wise precaution to drain the subcutaneous tissues with a soft rubber tube or with slender strips of corrugated rubber. The wound is closed in the usual manner, *i.e.*, a continuous or purse-string suture of No. 0 or No. 00 twenty-day chromic catgut is used to bring together the edges of the peritoneum, the muscular and aponeurotic layers are gently approximated with interrupted stitches of the same material, while the skin edges are evenly united with interrupted vertical mattress sutures of the finest silk or horse-hair (see fig. 8).

POST-OPERATIVE TREATMENT IN CASES OF
APPENDICECTOMY WITHOUT PERITONEAL DRAINAGE

This applies to those cases in which an acute unperforated appendix has been excised but in which it has been deemed inadvisable to drain the peritoneal cavity.

The post-operative treatment is that of the usual laparotomy, but as these cases comprise such a large proportion of surgical practice a brief note of the management is here given:

During the First Forty-eight Hours after Operation. As soon as the patient awakens from the anæsthetic, omnopon gr. $\frac{1}{6}$, morphia gr. $\frac{1}{4}$ or $\frac{1}{6}$, or heroin gr. $\frac{1}{3}$ or $\frac{1}{6}$, is injected subcutaneously. Some six to eight hours later another injection is usually required, and at night toward the end of the second day it is customary to prescribe a further injection. After this time pain, if present, is relieved by giving a mixture of aspirin and bromide by mouth, and sleep is ensured by such drugs as luminal, adalin, medinal, phanodorn, etc.

The patient is gradually placed in the semi-sitting position and is instructed to breathe deeply for a few minutes every hour during the day, to move his arms and legs freely and to change his position in bed from time to time. If there is no nausea, vomiting or marked distension, he is encouraged to drink water, barley water or sweetened fruit juice, in sufficient quantities to sate his thirst. No useful purpose can be served by withholding fluids at this stage, unless of course colicky pain or flatulent distension is provoked by these means. If the patient appears to be dehydrated and toxæmic, if vomiting proves troublesome, or if there is distension of the abdomen, fluids should be avoided. In such cases saline with 5 per cent glucose and perhaps 5 per cent alcohol is introduced intravenously by the slow drip method until there has been an all-round improvement in the patient's condition. It should be a rule that no solid food or even semi-solid nourishment should be given by mouth until a normal bowel action has been obtained. This implies that in the average case no solid food is given until the fifth or sixth post-operative day.

If the patient experiences any difficulty in passing water or if there is actual retention of urine, esmodil (Bayer) 1 cc. injected intramuscularly half-hourly for three doses usually acts like a charm. The patient will have to be catheterised if in spite of these injections (and commonly one injection alone suffices) the urinary retention is unrelieved.

Toward the close of the first forty-eight hours, 1 oz. of paraffin or some other suitable lubricant preparation is given orally.

On the morning of the third day after operation, provided that on abdominal auscultation peristaltic sounds are audible, a glycerine

enema is given. This may or may not be preceded by an intramuscular injection of $\frac{1}{2}$ to 1 cc. of pituitrin, pitressin or prostigmine. Paraffin, $\frac{1}{2}$ oz. three times a day, is then prescribed, and the dose is gradually reduced as soon as the bowels commence to work normally. No purgatives are administered to the patient until a good evacuation has been obtained with the aid of paraffin and glycerine enemata.

On the fourth day after operation, if there has been no natural bowel action, another glycerine enema is ordered. If this fails to produce a good faecal result, the enema should be repeated in a few hours' time. Under no condition must the colon be "washed out" or enemata containing large quantities of fluid be injected, as this might produce distension and temporary overloading of the gut, with the resulting danger of the appendix stump "blowing out" and thus leading to flooding of the peritoneal cavity with faeces and the irritating contents of the enema. This tragedy has occurred in two of my cases with fatal results. In one instance a portion of the caecal wall gave way, and on exploration the whole pelvic cavity was found to be filled with fluid which smelt of turpentine. In this instance the internal faecal fistula was converted into an external faecal fistula, and the pelvis was drained through a suprapubic stab wound. Unfortunately the patient died of an overwhelming toxæmia three days later.

From the fifth day after operation the patient is given a mild laxative, such as liquid cascara evacuant, 1 drachm nightly, and paraffin, 1 oz. daily, the dose of these two drugs being gradually reduced on subsequent days.

Solid food is now permitted, and a tonic mixture is prescribed. The skin stitches are removed on the fifth or sixth day, and a light dressing is applied to the wound. The patient is allowed out of bed on the eighth or ninth day.

THE TREATMENT OF ACUTE APPENDICITIS AFTER FORTY-EIGHT HOURS' DURATION

What treatment should we advise for those cases which are first seen on the third, fourth or fifth day of the disease, when there is evidence of local peritonitis or of an appendix abscess? Should we carry

out an immediate operation or should we treat such cases on expectant lines?

It is generally agreed that *prompt surgical intervention* is advisable:

1. In the case of children and the aged. It is often difficult to obtain an accurate history in children, and purgatives are automatically administered to children with "stomach-ache." In children, appendicitis often starts as an obstruction, perforation occurs with great rapidity, and the walling-off process is commonly lacking. Again, the peritoneum in a child is so extremely active that absorption from it may take place with such speed that the dose of toxin absorbed is overwhelming and fatal. Brockman (*Brit. J. Surg.*, 11:690, 1924) has emphasized this point. Unless therefore there is some very cogent contrary reason, immediate operation should be carried out in children suffering from appendicitis, irrespective of the time factor.

- In the aged, gangrene of the appendix develops speedily and the patient's resistance is low. Hermon Taylor (*Lancet*, 2:937, 1935) has shown that expectant measures in aged patients are frequently doomed to failure.

2. When a measure of uncertainty exists between a diagnosis of acute appendicitis and of some other intra-abdominal catastrophe normally requiring urgent operative interference, *e.g.*, perforated duodenal ulcer, perforated diverticulitis, etc.

3. When general peritonitis has supervened.

4. When hyperæsthesia is present. Hamilton Bailey (*Emergency Surgery*, 3rd ed., 1938) states that provided the other signs are confirmatory, this may be taken as good evidence that the appendix is still unperforated.

5. When the patient has been given one or more doses of some strong purgative after the onset of the attack. Here perforation with spreading peritonitis is very prone to occur.

6. When the surgeon in charge of the case has no experience of the Ochsner treatment.

7. When for one reason or another it is impossible for the surgeon to keep a watching brief on the patient and it would seem that a policy of armed expectancy is likely to fail.

8. When the disease has pursued a mild or sub-acute course. Here,

immediate appendicectomy is usually a straightforward and time-saving procedure.

9. In obese patients. Here it is very difficult to estimate the full extent of the inflammatory process owing to the thick layer of fat covering the abdomen.

EXPECTANT TREATMENT (DELAYED OCHSNER OR OCHSNER-SHERREN)

This is advised:

1. For those patients who have recovered from an attack of acute appendicitis.

2. For those in whom a *firm* localised mass is present around the appendix. Here nature has succeeded in walling off the infected focus with omentum and with neighbouring coils of small intestine, and no immediate danger threatens the patient. Operation carried out at this stage may lead to complications which might otherwise have been avoided.

3. For those patients who have developed a pelvic abscess.

4. For the patient who is suffering from frank general peritonitis and who is obviously too ill to withstand the ordeal of laparotomy.

5. For the patient who has successfully weathered perforation with diffuse peritonitis and who some five or seven days after the onset is found, on examination, to have a slow pulse and a distended abdomen. Here the appendix shrouded in adhesions has, as it were, shot its bolt and the Ochsner treatment offers the surest hope of cure.

Details of Expectant Treatment. The treatment should only be carried out in a well-equipped hospital which has a resident and nursing staff fully trained in the method. The surgeon should supervise the treatment, examine the patient at least twice a day, and hold himself ready to operate at a moment's notice should this prove necessary. It is not a suitable line of treatment for the family doctor to pursue in the patient's own home. It is undoubtedly the method of choice for late cases of appendicitis in which the infection appears to be resolving favourably or progressing to a localised abscess. It is designed, as Illingworth puts it, to supplement the natural attempts at healing so that operation may be delayed until the dangers peculiar to the critical stage have passed.

It should be remembered, as Lundgren, Garside and Boice (*Surg.*,

5:813, 1939) have pointed out, that Ochsner recommended this régime only as a preparation for operation. He originally reported the details of 1,000 patients thus treated at the Augustana Hospital, Chicago, in whom the total mortality was 2.2 per cent.

The aims of the treatment are: (1) to keep the inflamed parts at rest, and (2) to counteract the toxæmia.

The history of the case is taken and a note is made of the number of hours since the onset of the disease. The physical signs are graphically recorded on the chart. The essential items of the treatment may be briefly sketched as follows:

1. *Fowler's Position.* The patient is placed in bed in the sitting position so that any peritoneal exudate may gravitate toward the pelvis.

2. *Charts.* The pulse-rate is recorded hourly and the temperature four-hourly. A record is also kept of the number of times the patient vomits or passes urine.

3. *Fomentations.* These are applied to the abdomen at intervals of two or three hours (when the patient is awake) to relieve pain.

4. *Fluids.* During the first forty-eight hours of the treatment no fluids are permitted by mouth. McNeill Love (*Lancet*, 1:1252, 1939) states that until recently small quantities of fluid were customarily administered by mouth, a procedure which was obviously physiologically unsound as the entry of fluid into the stomach at once causes relaxation of the iliocecal sphincter with consequent local peristalsis. This danger is now precluded by the employment of the continuous intravenous infusion of saline and glucose, a method which has done much to safeguard the patient during the early phase of expectant treatment. At the end of forty-eight hours, if all is progressing satisfactorily, the patient is given water, glucose, lemonade, or similar fluids by mouth. No solid food is permitted until the bowels are working normally and until all signs of infection have disappeared.

5. *Drugs.* Most surgeons forbid the use of any drug so long as the inflamed appendix remains in situ. Morphia and its derivatives are not injected, as it is said that these may mask those all-important signs which herald the failure of expectant treatment. Is this wise? I frequently give a small injection of morphia or omnopon to nervous and apprehensive patients at the commencement of the treatment to find that by the time the next examination is due the anodyne

effects have completely worn off. This small dose of morphia seems to do nothing but good at the very outset of the treatment when it would appear to be particularly required. Where toxæmia is marked, anti-gas gangrene serum given intravenously appears to be of some help. Sulphanilamide or sulphapyridine (M. & B. 693) is prescribed with benefit in certain cases.

6. *Aperients and Enemata.* The bowels should not be disturbed but should be left to act naturally if possible. If there has been no evacuation by the end of the fourth day it is customary to give a small glycerine enema on the morning of the fifth day, but if the patient is comfortable even this may be withheld until the end of the first week. No aperients are given until the infection has completely resolved.

7. *Duodenal Suction.* This may be indicated for the relief of distension and ileus.

Signs of Failure of the Expectant Treatment. These may be enumerated as follows:

1. Steadily rising pulse-rate. If any significant increase is noted, and more especially if it is maintained, it is far better to operate at once than to temporise.

2. Vomiting. Repeated vomiting is an indication for immediate operation.

3. Exacerbation of pain and increasing local rigidity. This is a sign that the infection is spreading and is an urgent plea for immediate surgical measures.

4. A localised abscess fails to resolve. Love considers that visceral degeneration is a possible consequence of prolonged toxæmia, and that drainage of the abscess shortens the period of disability.

5. *A localised abscess continues to increase in size. Here there is a real risk of rupture of the abscess into the general peritoneal cavity.* A spontaneous cure sometimes results when an abscess ruptures into the bowel, but it is risky to wait unduly long for this process to take place.

THE TREATMENT OF APPENDIX ABSCESS

As has already been described, the position of the appendix will be found to vary greatly in different individuals and in the same individual at different times. Whatever the position of the appendix,

an abscess may form in connection with it. An abscess may therefore occupy the right iliac fossa, it may lie behind the cæcum, it may form in the paracolic gutter to the outer side of the ascending colon, it may be situated mesially when the tip of the appendix points toward the spleen or toward the promontory of the sacrum, or again it may occupy the space between the bladder and rectum in the male or between the bladder and uterus or uterus and rectum in the female—pelvic abscess. In some rare instances an appendix abscess may be found in the sub-hepatic space or on the left side.

The signs of an appendix abscess are those of acute appendicitis in addition to the presence of a tender circumscribed mass. The symptoms are due to toxic absorption.

There are two types of appendix abscess: (1) the recent abscess of twelve to twenty-four hours' duration. This is commonly a local collection of pus pooling around the perforated appendix and completely shut off by great omentum and adjacent coils of intestine which are loosely gummed together, and (2) the established abscess. This is generally a few days old and the surrounding structures are densely adherent.

There are two methods of treatment—immediate operation and expectant measures.

Immediate operation is often the method of choice for the recent abscess of, say, twelve to twenty-four hours' duration. Here it is commonly possible to excise the adherent portion of omentum together with the perforated appendix en masse and thus complete a clean and relatively atraumatic operation. But in the established abscess, delayed treatment is by far the safer measure. If an immediate operation is carried out it is often extremely difficult or even impossible to see the appendix, and searching for the diseased organ with the finger or with the aid of firm retraction in congested and friable tissue may separate the protective barriers and adhesions and thus lead to a spread of infection—maybe into the general peritoneal cavity. At times the appendix may readily present and may, in fact, be easily shelled out of its œdematous bed without much ado; but this should not be reckoned upon as it is an uncommon state of affairs to find at operation.

What is the relative mortality of the two lines of treatment? The average mortality of immediate operation is about 6 per cent, while

that of expectant treatment is under 3 per cent. In cases of appendix abscess treated by the Ochsner method, reliable statistics show that in 70 per cent the mass slowly and completely resolves. In these fortunate cases the appendix should be excised after an interval of six months, when most of the adhesions have completely melted away. In 30 per cent, drainage of the abscess becomes imperative owing to an exacerbation of pain, to an increase in the size of the abscess or its rupture into the general peritoneal cavity, or to the tardy absorption of the walled-in pus.

Technique of Drainage.—1. *For Appendix Abscess Situated in the Right Iliac Fossa.* After the patient has been anæsthetised, the surgeon should carefully palpate the swelling and make a small incision over the most projecting and superficial part of the abscess. The peritoneum should be opened cautiously, as coils of intestine may be adherent to its under-surface. As a rule the abscess does not abut against the anterior abdominal wall, and when the œdematous peritoneum is incised the matted mass can often be seen in the depths of the wound.

Two small retractors are inserted into the wound to separate and elevate its margins, while the peritoneal cavity is very gently packed off with long strips of dry gauze. The surgeon should aim at erecting an impenetrable barrier all around and more especially on the medial side of the indurated mass. The index finger is then inserted through the wound down to the most prominent and cystic portion of the abscess wall. At this point the finger is slowly introduced into the abscess cavity and a fair-sized rubber tube is led down through this opening into the cavity to give free vent to its foul-smelling creamy contents.

The wound is speedily closed with a few through-and-through interrupted sutures of stout silkworm gut. The tube which drains the abscess cavity is left undisturbed for forty-eight hours. After this time it is rotated and shortened daily, and by the end of a week it can, as a rule, be withdrawn.

2. *For Appendix Abscess Situated in the Right Flank or in the Retrocæcal Space.* In these cases the purulent collection may with advantage be reached and effectively drained by employing the retro-peritoneal approach. With the patient lying on his left side on the operating table with the right flank extended and freely exposed, as in

an operation upon the kidney, a transverse or oblique incision is made midway between the iliac crest and the tip of the tenth or eleventh rib, and after dividing the muscular layers of the abdominal wall the swollen peritoneum is exposed and carefully stripped medially for a variable distance in the manner employed for exposing the ureter. The index finger then burrows gently inward and slightly downward to reach the retrocæcal fossa until a "give" is felt and the finger thereupon enters a large cavity. A rubber tube is instantly inserted into the abscess cavity and the edges of the wound are lightly approximated.

3. *For Pelvic Abscess.* Pelvic abscess, as has been previously shown, may form and give rise to few if any constitutional disturbances, and there may in addition be no physical signs on abdominal examination. The characteristic features of a pelvic abscess are diarrhœa and the passage of mucus in the motions. The abscess may bulge into the rectum or into the posterior vaginal fornix (fig. 211 [1 and 2]).

On rectal examination a tender cystic mass can readily be felt, but operation should be deferred until it is on the point of perforating the rectum. If the abscess actually points into the vagina it should be drained through an incision in the posterior fornix—posterior colpotomy. In most cases, however, rectal drainage is preferable.

The technique is simple and safe, and the immediate and remote results are excellent. The bladder is emptied with a catheter and the patient is placed in the lithotomy position with a sandbag under the lower part of the back. A long narrow-bladed retractor or a small vaginal retractor is inserted into the rectum, the posterior wall of which is firmly depressed. The bulging anterior rectal wall at once comes into view and if it does not do so the index finger should be inserted into the rectum to locate the site of maximum softening. Through this area the points of closed artery forceps are gently and evenly forced in an upward direction. As the points of the forceps enter the abscess cavity, evil-smelling pus will gush downward with great force. The small opening into the abscess cavity should be enlarged with the point of the index finger and a rubber tube should be introduced into the cavity and then attached by a single stitch to the anal margin. The tube is left in position for three or four days, but after it is removed there may still be a slight discharge of

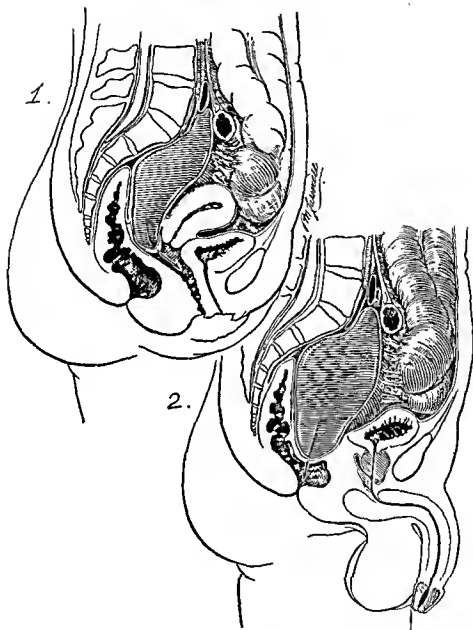


FIG. 211.—PELVIC ABSCESS.

- (1) The abscess is bulging into the posterior vaginal fornix.
- (2) The abscess is pointing into the rectum.

mucopus for a short while. In most cases convalescence is speedy and uninterrupted, but appendicectomy is best deferred for a period of six months, not three months as is so frequently recommended.

TREATMENT OF APPENDICITIS WITH GENERAL PERITONITIS

The first step in treatment is the immediate preparation of the patient for operation. This does not imply, however, that an immediate operation is carried out in all cases. Even where it is obvious that an urgent laparotomy is necessary, considerable improvement in the patient's general condition can often be achieved by a brief course of treatment—an hour or so—which includes aspiration of the gastric contents, intravenous infusions of saline with glucose and perhaps 5 to 10 per cent alcohol, and the application of heat to the abdomen. In a few cases in which operation is clearly contra-indicated, these preliminary measures gradually merge into those of the Ochsner method. It is unwise to proceed with immediate operative measures when the patient is gravely ill and profoundly toxæmic, when the pulse is rapid, thready or almost imperceptible, when the temperature is sub-normal, and when other factors indicate that the peritonitis is far advanced. Likewise, an expectant attitude should be adopted when the patient has succeeded in weathering the first critical days of the disease and when on examination, conducted perhaps a week after the onset of the attack, he does not appear to be seriously ill, when the pulse is relatively slow and steady, and when Nature has transformed a general peritonitis into a collection of pus localised to the right iliac fossa, the hypogastrium or the pelvis.

When the surgeon decides to operate, as he will do in the majority of cases, he has the choice of two procedures:

(1) removal of the appendix plus suprapubic drainage and possibly drainage of the retrocæcal space; and (2) drainage of the peritoneal cavity alone, the appendix being left in situ.

If we exclude those cases of general peritonitis which are due to the recent rupture of an appendix abscess, where it is generally conceded that drainage of the abscess cavity combined with separate drainage of the pelvis through a suprapubic stab wound is all that should be attempted in order to achieve success, we find that the best results in this desperate disease are obtained when the appendix is excised and drainage provided. The outlook is exceedingly grave in those cases where the fecal contents are free to pour into the peritoneal cavity and where at operation an attempt—and this may be a determined one—to excise the gangrenous structure has failed or

has had to be abandoned in favour of simple drainage early in the operation owing to technical difficulties or the collapsed condition of the patient.

The principal cause of death in acute appendicitis is diffuse peritonitis. When this lethal complication is present, the mortality can only be reduced by the exercise of supreme generalship and good judgment on the part of the surgeon. He must carefully plan the line that pre-operative treatment should take; he must constantly review the facts of the particular case with the greatest deliberation; he must discriminate between the case which is in need of immediate operation and the one which must be treated on conservative lines; he must obtain the services of a highly skilled anæsthetist; and when he does operate he must do so with the utmost dexterity and speed.

THE MORTALITY OF APPENDICITIS

Chronic appendicitis—appendicectomy—under 1 per cent.

Acute appendicitis without perforation—appendicectomy—under 1 per cent.

Appendicitis with abscess—Ochsner method or expectant treatment—3 per cent.

Appendicitis with abscess—immediate operation—simple drainage—6 per cent.

Appendicitis with abscess—immediate operation—appendicectomy plus drainage—8 to 10 per cent.

Appendicitis with general peritonitis—appendicectomy plus drainage—20 to 25 per cent.

Appendicitis with general peritonitis—drainage alone—30 to 45 per cent.

Causes of Death. Peritonitis 80 per cent; pneumonia 10 per cent; septicæmia 5 per cent; vascular accidents 3 per cent; other causes 2 per cent.

THE TREATMENT OF APPENDICITIS IN PREGNANCY

It is always a matter of the greatest difficulty to arrive at an accurate diagnosis, as acute pyelitis of pregnancy, toxæmic vomiting, "red degeneration" of a uterine fibroid, torsion of an ovarian cyst,

and acute salpingitis closely simulate the clinical features of acute appendicitis. Appendicectomy leads to miscarriage in about 25 per cent of cases if performed during the first three months of pregnancy. After this time the liability to abort steadily decreases.

If the case is seen *early* in the course of the disease and if the signs and symptoms support a diagnosis of acute appendicitis, the organ should be removed promptly. Again, operation should not be delayed when it is clear that the disease is progressing rapidly, when vomiting is repeated, when there is marked local rigidity, and when the area of tenderness is found to be enlarging. In other cases, and more especially when the condition is less acute and the infective process is definitely localised, an expectant attitude should be adopted and the treatment carried out on the lines described on page 891.

POST-OPERATIVE COMPLICATIONS

Post-operative complications are rarely seen when the unperforated appendix is removed intact. The following list chiefly concerns the late cases in which appendicectomy has been carried out after the organ has perforated and there is local or general peritonitis: (1) infection of the wound (page 39); (2) disruption of the wound (page 48); (3) incisional hernia (page 1011); (4) thrombo-phlebitis of the femoral and pelvic veins (page 865); (5) pulmonary embolism (page 1351); (6) pyelephlebitis (page 865); (7) sub-phrenic abscess (page 944); (8) residual abscess (page 920); (9) intestinal obstruction due to adhesions (page 1139); (10) paralytic ileus (pages 930, 1097); (11) perinephric abscess; (12) bronchitis and pneumonia (page 1343); (13) faecal fistula.

Faecal Fistula. There are two varieties—external and internal. This complication is commonly due to erosion of a portion of the caecal wall by a drainage tube, to necrosis of a circumscribed part of the caput caeci, or to the giving way of the ligatured appendix stump.

External Faecal Fistula. It is sometimes exceedingly difficult to distinguish between a faecal fistula and a discharging hæmatoma infected with *B. coli*. The discharge from a *B. coli* abscess may simulate that from a faecal fistula in that it may be highly offensive and dark brown in colour, and gas may bubble up from time to time from the depths of the wound. Eventually, however, the true nature of

the discharge—liquid faeces—leaves no room for doubt. In some cases of general peritonitis the occurrence of a faecal fistula may be a blessing in disguise, the fistula acting as an enterostomy.

A faecal fistula has to be distinguished from a persistent sinus. A persistent sinus following appendicectomy may be due to retention of a drainage tube, a swab, an unabsorbed suture or a faecal concretion. Actinomycosis is another rare cause of a persistent sinus and is discussed on page 907.

Treatment. The majority of external faecal fistulae following appendicectomy undergo spontaneous cure, and it is rare for a secondary operation to prove necessary in order to close them. The immediate treatment consists of withdrawing the drainage tube, of protecting the surrounding skin with zinc oxide and castor oil paste or with lanoline, and of removing a few skin stitches to give free vent to the discharge. The patient should be ordered a non-residue diet, and bismuth oxycarbonate, grs. 30 six-hourly, and/or pulv. cretæ aromat. cum opio, one drachm four-hourly. A daily saline bowel wash-out or soap enema is given until the fistula closes. No purgatives are administered by mouth.

If the wound is severely infected and there is evidence of pocketing of pus, a small counter incision should be made for drainage purposes.

A faecal fistula will not close spontaneously if the mucous membrane of the gut is continuous with the skin. In such cases operation, which is performed in the following manner, will be necessary:

The fistulous opening is lightly packed with gauze to prevent any discharge, and the surrounding skin is thoroughly swabbed with alcohol. The fistulous opening is closed with a purse-string suture of strong silkworm gut, after which an oval incision is made in the skin to include the invaginated area, and this may be further extended at each end. The incision surrounding the fistula is carried through all the layers of the abdominal wall until the peritoneum is reached. The peritoneum is opened at the upper and lower ends of the wound to free adhesions and to isolate as far as possible that portion of the gut from which the fistula arises.

As soon as the cæcum has been sufficiently mobilised the parietal peritoneum attached to the upper portion of the isolated segment of the wound is divided with scissors, which permits the gut to be

withdrawn through the wound. The fistulous tract with its attached portion of abdominal wall is removed by excising the base of the fistula through an incision in a healthy area of the gut wall. The resulting gap in the intestine is closed transversely by a two- or three-tier suture.

Internal Fæcal Fistula. This tragedy is of rare occurrence and is due to a portion of the cæcal wall or the appendix stump giving way some four to six days following appendicectomy. Probably the commonest exciting cause is the administration of a large enema which unduly distends the gut and causes it to rupture at some weakened spot. The general peritoneal cavity at once becomes flooded with fæcal contents and with the substance of which the enema is composed, and a virulent diffuse peritonitis very rapidly ensues.

The only hope of saving the patient's life is immediate laparotomy and the conversion of the internal fæcal fistula into an external one by the performance of cæcostomy. In such cases the pelvis should be drained through a separate incision. Petty (*Brit. M. J.*, 2:491, 1933) has given an excellent account of internal fæcal fistula together with its treatment.

CHAPTER 3

CHRONIC APPENDICITIS

There are a number of surgeons and pathologists who have expressed doubts as to the existence of chronic appendicitis as a clinical and pathological entity; but nevertheless all the available evidence supports the view that the disease not only occurs but is relatively common, that it is associated with certain characteristic signs and symptoms, and that in many cases it accounts for much ill-health.

CLINICAL TYPES

The following clinical types may be recognised:

1. **Recurrent Appendicitis.** In this type there is a clear history of an acute attack in the past. The attacks are intermittent. The symptoms, which are due to some reflex gastro-intestinal upset, are expressed as dyspepsia, and on examination tenderness is usually found over the appendix.

2. **Recurrent Appendicular Colic.** An appendix containing thread-worms, faecal concretions, pips or stones of fruit, lead pellets swallowed in shot game, and other foreign bodies may, on occasion, produce recurrent attacks of colicky abdominal pain due to the strenuous peristaltic movements of the appendix in its endeavour to expel the object or objects caught up in its lumen. The cramp-like pains are often localised to the region of the umbilicus or situated a little below this and to the right or higher up in the epigastrium. Other prominent symptoms include nausea, flatulent distension, eructations, fatigue syndrome, and an occasional bout of vomiting. On palpation there is often some degree of tenderness in the right iliac fossa, and firm pressure over the appendix sometimes produces pain in the epigastrium or beneath the left costal margin. In a few cases a slightly tender tumour may be made out in the right iliac fossa.

The diagnosis is to be made from other conditions which cause

colicky spasms, such as constipation, "spastic colon," abdominal tuberculous lymphadenitis, adhesions, and right-sided tubo-ovarian disease.

3. **The Grumbling Appendix.** In this type the patient often complains of pain or a dragging sensation in the right iliac fossa. The pain is never so acute as, for example, in ureteric colic, but it may nevertheless be sharp, stabbing or "drawing" in character. It may last for a few minutes or some hours, and when it passes off it leaves behind a dull ache in the side. This ache may be accentuated on walking or taking exercise.

Examination of the abdomen may reveal a point of tenderness over an area no larger than an inch circle at or about McBurney's point. The teasing pains recur at frequent intervals and the general health may show some deterioration.

4. **Appendix Dyspepsia.** The symptoms produced by indolent inflammation of the appendix in some respects resemble those of chronic peptic ulcer. The symptoms are the result of a reflex pylorospasm. When a careful history of these cases is taken the resemblance of the symptoms to those of chronic peptic ulcer is, in fact, found to be very superficial. The dyspepsia is, for instance, more or less continuous and although there is no typical periodicity there are irregular short attacks of sharp pain. In the intervals between these attacks the patient is never quite free from symptoms. Nausea, which is rare in chronic gastric and duodenal ulcer, is fairly common in appendix dyspepsia. In chronic gastric ulcer vomiting gives instantaneous and complete relief from pain, whereas in appendix dyspepsia the relief afforded is incomplete. Pain, when present, is made worse by exercise, constipation, diarrhoea or the administration of purgatives. It appears to be unrelated to the ingestion of food. It may arise at any time before or after a meal, and neither diet nor alkalis will relieve it completely, although some mitigation of the symptoms may result from such measures.

As in duodenal ulcer, there may be nocturnal pain. The pain is often mid-epigastric in position, but frequently radiates to the right iliac fossa and may at times remain localised to the lower abdomen for a considerable period without producing any epigastric disturbance. When pain in the epigastrium is at its height, pressure over the appendix will be resented. Similarly, pressure in the epigastrium

will sometimes produce pain which is referred to the right iliac fossa. Even without the aid of radiology a provisional diagnosis can be made with more confidence in young patients than in those over the age of 30.

The best method of differentiating between appendix dyspepsia and chronic peptic ulcer is by means of an X-ray examination, especially when no ulcer crater is demonstrated on screening. In children, continuous or recurrent indigestion, biliousness, and suchlike minor gastric upsets, should call for a painstaking examination for evidence of chronic appendicitis.

PATHOLOGICAL TYPES

At operation the following pathological types of "chronic appendix" may be seen:

1. **The Proliferative Hyperplastic Type.** In this type of the disease the appendix is considerably thickened, fibrotic and rubbery in consistency, and is of a pale grey colour. The meso-appendix is shortened, stiffened and thickened. The mucous membrane is fleshy, and the rugæ are unduly prominent.

2. **The Obliterative Type.** Here a slow fibrosis of the wall of the appendix leads to obliteration of the lumen, until eventually the appendix resembles a piece of whipcord. The obliteration most frequently starts at the tip of the organ and gradually progresses toward the base (Aschoff, 1932). When the obliterative inflammation is confined to the base of the appendix, the proximal end frequently distends with mucus—mucocoele. Sometimes this proximal stricture leads to the formation of minute multiple diverticula, and on occasion to very large ones.

3. **The Appendix is Sharply Kinked on Itself and its Distal End is Bulbous.**

4. **The Appendix is Buried in many dense Adhesions and when Excised shows definite Evidence of Fibrotic Thickening.**

DIAGNOSIS

The diagnosis is often difficult and when doubt exists investigation should always precede exploration, as Wilkie has so frequently

emphasised. In my opinion, the greatest help is afforded by X-rays. A barium meal X-ray examination of the gastro-intestinal tract is of value in excluding other lesions such as duodenal ulcer, cancer of the cæcum, visceroptosis, etc.; on the other hand, on screening there may be the discovery of an area of tenderness over the appendix, giving positive evidence of disease of this organ. Skiagrams may show that the appendix contains large faecal concretions, that it is sharply kinked, that it is firmly fixed in one position, that it is unduly long and tortuous, or that it lies in a truly ectopic position. All of these are not positive proof of disease of the organ, but taken in conjunction with the clinical data they are at least strongly suggestive of chronic appendicitis. The normal appendix does not always fill after the administration of an opaque meal. Therefore, negative X-ray evidence does not necessarily signify that the lumen of the organ is blocked. In certain cases, and more especially in patients over the age of 40, in addition to the routine clinical and biological investigations which are normally carried out, it is important that the radiologist should submit a report on the condition of the stomach, duodenum, colon and gall-bladder, as associated lesions, such as gall-stones and chronic duodenal ulcer, are not infrequently found in chronic disease of the appendix.

DIFFERENTIAL DIAGNOSIS

The diagnosis is to be made from:

(1) chronic constipation associated with cæcal distension; (2) colop-tosis; (3) chronic colitis; (4) chronic gastritis and duodenitis; (5) chronic peptic ulcer; (6) chronic cholecystitis and gall-stone; (7) tuberculous iliocæcal glands; (8) right-sided tubo-ovarian disease; (9) carcinoma of the proximal colon; (10) chronic pyelitis; (11) neurosis.

TREATMENT OF CHRONIC APPENOICITIS

In children, adolescents and those in whom the diagnosis is reasonably assured, it is best to remove the appendix through a small gridiron incision. For cosmetic reasons the incision should be made obliquely or transversely in one of the natural creases of the skin,

and should, where possible, be placed directly over the appendix when its position has been revealed by radiology or by the eliciting of the cæcal gurgle on firm palpation.

In females after such an appendicectomy, the uterus, fallopian tubes and ovaries should be palpated with the index finger. When it seems desirable to arrive at a diagnosis by the process of elimination, it is far better to employ a limited McBurney incision which has no death-rate and no sequelae and involves the minimum loss of time rather than a wide laparotomy. In women, however, when it is thought that there may be some coincident pelvic disease, the abdomen should be explored either through a right paramedian sub-umbilical incision or by Pfannenstiel's transverse suprapubic incision. When there is radiological or other evidence of a co-existent destructive upper abdominal lesion, *e.g.*, duodenal ulcer, gall-stones, etc., most surgeons would advise a somewhat lengthy right paramedian incision so that the multiple abdominal lesions can be satisfactorily dealt with through one incision. Nevertheless, in such cases I prefer two incisions—an epigastric (vertical or transverse) incision for approaching the lesion in the upper abdomen, and a small grid-iron incision for the appendicectomy. In some fortuitous cases where the cæcum is unduly mobile, the appendix may be simply drawn through the epigastric incision and removed in the usual manner.

ACTINOMYCOSIS OF THE APPENDIX

The infection may start in the ilio-cæcal region or in the appendix itself. There are two common clinical types:

1. The type which resembles acute catarrhal appendicitis. Here the signs and symptoms are those of a mild attack of appendicitis, and when the swollen inflamed organ is removed and when afterward all seems to be progressing favourably the wound breaks down and discharges thin watery yellowish pus, the true nature of the disease remains undetected until an examination of the pus shows the typical "sulphur" granules.

2. The type which resembles an appendix abscess. Here a firm mass in the right iliac fossa is found on examination. It is at first almost impossible to differentiate between tuberculous disease of the ilio-cæcal region, cancer of the cæcum, an unresolved appendix

abscess and actinomycosis of the right iliac fossa. At a later stage when multiple sinuses form and when the liver shows evidence of involvement, the true condition becomes apparent.

When the appendix or the ilio-cæcal region is the site of a streptothricial invasion, the pathological processes are in many respects similar to those occurring in other parts of the body. These are a low-grade inflammation leading to an adhesive peritonitis, induration preceding the formation of tumour-like masses, and abscess formation. These abscesses are due to secondary infection, and eventually rupture on to the surface, producing external fistulæ, or into some adjacent viscus such as the large bowel, small intestine or bladder. Intestinal obstruction very rarely occurs. The streptothrix fungus may burst into the venous radicles of the portal system and be carried to the liver where it grows exuberantly.

TREATMENT

In the advanced cases when there is a firm rock-like mass in the right iliac fossa with multiple external fistulæ, operative measures will consist in draining the abscesses, curetting the sinuses, preventing the access of secondary organisms and possibly short-circuiting the diseased area by the performance of ilio-transverse colostomy. It is doubtful whether the shunting of the intestinal contents into the colon is of any value, as the inflammatory process very rarely leads to obstruction of the bowel. In the early case, however, when the disease is limited to the ilio-cæcal region, a wide block excision of all the structures which are involved should be favourably considered. Deep X-ray treatment is sometimes of decided value, but vaccines, after an extended trial, have on the whole proved disappointing. Certain arsenical and mercurial preparations have been used from time to time, but without any success. Sulphanilamide and sulphapyridine are still on trial in the treatment of this disease; but one can appreciate that when secondary infection is concomitantly present, these drugs will exert a beneficial influence. Potassium iodide in milk is prescribed for all cases. The dose should be increased rapidly up to 200 grs. daily, and the treatment with this drug should be maintained for several weeks.

DIVERTICULA OF THE APPENDIX

Diverticula of the appendix are not very rare, and the causes of the condition are unknown. Diverticula may become inflamed or even perforate, and are occasionally responsible for the production of pseudo-myxomatosis of the peritoneum. In this last condition the abdomen slowly distends with a gelatinous exudate not unlike frog's spawn, and laparotomy is advised to ascertain the cause of the trouble.

TUMOURS OF THE APPENDIX

True primary carcinoma of the appendix, *i.e.*, malignant columnar-celled carcinoma, is exceedingly rare. By far the commonest neoplasm of the appendix is the so-called carcinoid tumour which has been so excellently described by Masson (*Am. J. Path.*, 4:181, 1928). Carcinoid tumours are not solely confined to the appendix. They are, in fact, most frequently found in the small intestine, and when occurring there they are usually multiple. The disease affects young subjects, but females more often than males, and shows a predilection for the tip of the organ, although Wilkie (*Brit. J. Surg.*, 8:392, 1921) described a number of cases in which the tumour was situated near the base of the appendix and was apparently responsible for obstruction—chronic obstructive appendicitis and sub-acute inflammation.

When the neoplasm occurs near the tip of the appendix, it forms a hard, yellowish, oval or circular tumour which has a diameter of about $\frac{1}{2}$ inch or so. This slow-growing tumour is benign in character. It never gives rise to distant metastases, nor does it ever involve adjacent lymph nodes. On microscopical investigation it is difficult to distinguish these carcinoid tumours from true carcinoma.

The *treatment* is appendicectomy, and nothing else needs to be done as recurrence at some later date is not to be feared.

PART VIII

PERITONEUM, MESENTERY, OMENTUM

CHAPTER I

ACUTE PERITONITIS

By far the most important subject in this section is peritonitis. No study of this disease would be complete without specific reference to Hertzler's monograph *Surgical Pathology of the Peritoneum* (1935), to his authoritative synopsis on peritonitis in Christopher's *Text-book of Surgery* (1939), to Livingston's *A Clinical Study of the Abdominal Cavity and Peritoneum* (1932), and to Cope's *The Early Diagnosis of the Acute Abdomen* (1935). The well-written, vivid and valuable contributions of Cokkinis have been a source of constant inspiration to me.

I propose to deal first with that type of acute peritonitis which is due to infection of the peritoneal cavity with pyogenic organisms.

Aseptic peritonitis, a condition which has received special emphasis from Hertzler, results from some irritation other than that of bacterial origin. It may be caused by the introduction into the peritoneal cavity of certain fluids or chemical preparations for therapeutic purposes, or it may result from blood, bile, gastric juice, urine or pancreatic juice being free to escape into the peritoneal cavity; but here, although the peritoneal exudate is in the first instance non-infective, sooner or later bacterial invasion occurs and the peritonitis becomes frankly infective in character.

Acute peritonitis may be *diffuse*, *diffusing* or *localised*, and from an ætiological point of view it may be conveniently divided into *primary*, *secondary* and *post-operative*.

When the peritonitis occurs for no apparent reason and when there is no discernible initiating lesion within the abdominal cavity, it is termed primary; it must be remembered, however, that even in such cases the peritonitis is, in fact, secondary in nature, as the infecting organisms, which are usually streptococci or pneumococci, are brought to the peritoneum from some distant focus by the blood stream or possibly via the lymphatic channels, or via the genital tract in females.

Secondary peritonitis, which is the terminal event in most acute abdominal emergencies and also in many of the more chronic lesions, may complicate almost any abdominal condition, whether it be traumatic, infective, ulcerative, obstructive or neoplastic.

Post-operative peritonitis is a relatively common sequel of abdominal operations and more particularly of resections of the stomach or large gut.

ÆTIOLOGY

The causes may be grouped as follows:

1. **Acute Infections.** The best examples are appendicitis, cholecystitis, diverticulitis, pancreatitis, salpingitis and uterine and pelvic sepsis. Appendicular peritonitis is the commonest variety of peritoneal infection and accounts for about 40 per cent of the total number of deaths from peritonitis. It is distressing to consider that the greatest incidence occurs in patients from 20 to 30 years of age.

2. **Acute Perforations.** These may involve the stomach, duodenum, small intestine, colon or gall-bladder. Acute perforated peptic ulcers are responsible for about 20 per cent of the deaths. In this group are also included perforated stercoral and typhoid ulcers, perforated diverticulitis, perforation of a malignant growth of the stomach or colon, and perforation of the intestine in cases of acute ulcerative colitis, tuberculous enteritis and so forth.

3. **Injuries of any Hollow Viscus.** These may be produced by subcutaneous trauma or penetrating wounds, *e.g.*, rupture of the jejunum or laceration of the colon.

4. **Rupture of a Solid Organ, *e.g.*, Liver, Spleen, etc.** Here acute infective peritonitis ensues when the resulting intra-peritoneal hæmatoma becomes infected with pyogenic organisms.

5. **Operative Accidents and Faulty Technique in the Conduct of Abdominal Operations.** Pflaum (*Am. J. Clin. Path.*, 5:131, 1935), in a report based on 1,000 cases of peritonitis which were found in 14,263 autopsies, states that there were 221 cases (22.1 per cent) of post-operative peritonitis. This does not include cases in which operation was performed when peritonitis was already present, *e.g.*, perforated appendicitis or ruptured peptic ulcer. Resection for carcinoma of the stomach or colon was responsible for most of the post-operative deaths. Among the operative accidents are included ten

cases of acute peritonitis which developed after paracentesis for ascites.

6. **Ascending Infections of the Female Genital Tract, e.g., Gonococcal, Streptococcal (especially Puerperal Sepsis) and Pneumococcal Infections.**

7. **Simple Obstructive Lesions of the Intestines and Torsion and Strangulation of Solid or Hollow Viscera.** These are simple obstruction, torsion of the pedicle of an ovarian cyst, internal strangulation, Richter's hernia, and intussusception.

8. **Blood-Borne Infections.** These may be encountered in certain cases of streptococcal and pneumococcal peritonitis.

9. **Contamination of the Peritoneal Cavity with Certain Fluids.** These are the pancreatic juice, bile and urine.

10. **Other Possible Causes.** These include umbilical sepsis in newborn infants and spread of infection from the thorax via the lymphatic channels, e.g., empyema.

BACTERIOLOGY

As might be expected, the micro-organisms which normally inhabit the intestinal canal play an important rôle in the production of peritonitis. In the healthy individual these micro-organisms are to all intents and purposes non-pathogenic, but in the presence of perforation of a hollow viscus or of inflammation or strangulation of a part of the intestinal tract they become transformed in character and take on a greatly increased virulence. The bacteria most often responsible are:

(1) *Bacillus coli*; (2) streptococcus; (3) staphylococcus; (4) pneumococcus; (5) gonococcus; (6) *Bacillus pyocyaneus*; (7) *Bacillus proteus*; and (8) *Bacillus welchii* and other anaerobes. The infection is often mixed.

B. coli is the commonest causal organism in peritonitis of appendicular or intestinal origin, and it also appears in luxuriant growth in the peritoneal exudate in the later stages of peritonitis from other causes. The exudate is purulent, abundant and flaky, and often—although by no means always—has a strongly offensive faecal odour. When the infection is a pure one it produces a relatively benign type of peritonitis. In the majority of cases, however, the infection is

mixed. The *B. coli* has an inherent propensity for rapidly out-growing and completely overwhelming other bacteria, notably streptococci, in the peritoneal exudate.

The *streptococcus* is the cause of the most lethal and virulent varieties of widespread peritonitis. It accounts for about half of the cases of so-called primary peritonitis. It is found, sometimes in pure culture, in post-operative and puerperal infections of the peritoneum. It is also the causative organism in the grave types of peritonitis complicating appendicitis, cholecystitis, diverticulitis and other abdominal infections, and also in the more serious infections which follow penetrating wounds of the abdominal viscera. The exudate in streptococcal peritonitis is thin and watery, is sometimes tinged with blood or is very slightly purulent, contains, as a rule, no flakes of fibrin, and is odourless.

The *pneumococcus* accounts for the remaining 50 per cent of primary cases. It is sometimes encountered in peritonitis of appendicular, puerperal or pelvic infection, and also in the comparatively rare cases of peritonitis which complicate suppurative lesions in the chest, e.g., pneumonia. Pneumococcal peritonitis is described on page 936.

The *gonococcus* usually causes a local pelvic peritonitis, but on rare occasions it may be responsible for a diffuse infection of the entire peritoneal cavity. Gonococcal peritonitis occurs principally, in fact almost invariably, as a complication of gonorrhœa, being due to a direct spread of the infection along the fallopian tubes and then through the abdominal ostium, or to the rupture of a tubo-ovarian abscess. In a few cases gonococcal peritonitis may result from infection of the seminal vesicles, and there are instances recorded in the literature where the infection was hæmatogenous. The plastic exudate in this type of peritonitis is at first opalescent and odourless; later it becomes yellowish and creamy in consistency. When resolution occurs, dense adhesions form which bind the pelvic viscera into a matted mass.

The *anærobic bacilli*, and notably *B. welchii*, are commonly found in the peritoneal exudate in cases of rupture or of perforation of the intestine, in internal strangulation, and in late simple obstructions; but these bacilli are soon swamped by pyogenic organisms, and more especially by *B. coli*.

PATHOLOGY

The pathological changes which occur vary considerably according to: (1) the source of the infection; (2) the severity of the infection; (3) the age, general condition and resistance of the patient; (4) the promptness and efficacy of the method of medical or surgical treatment adopted.

The onset of acute peritonitis may be *sudden*, as in acute perforation or rupture of the intestine, or again it may be *gradual*, as in the case of inflammatory lesions such as non-perforative appendicitis, cholecystitis or salpingitis. Acute diffuse peritonitis is usually infective from the start, as has been previously stated, but when provoked by chemical irritation, it may remain non-infective for a period of many hours.

Bile peritonitis, due to the transudation of bile through the gall-bladder, is an interesting pathological study, and was first described by Clairmont and von Haberer in 1911. Leriche (*Presse méd.*, 31:232, 1923) described in detail a case in which at laparotomy bile was found to be oozing from a distended but intact gall-bladder. He performed cholecystectomy and drained the abdominal cavity. The patient made a good recovery.

Up to date a number of cases similar to those described by Clairmont and Leriche have been recorded in the literature, and the subject has received special attention from Harkins, Harmon and Hudson (*Arch. Surg.*, 33:576, 1936); Doidge and Warner (*Surg.*, 4:405, 1938); Wangenstein (*Ann. Surg.*, 84:69, 1926); and Marinelli (*Polyclin.*, 32:249, 1925).

When pathogenic bacteria are free to multiply in the peritoneal cavity the morbid changes which occur are characteristic. The peritoneum becomes hyperæmic and œdematous, and fluid is poured out, at first serous and clear, then turbid, and finally frankly purulent. The exuded fluid may or may not contain fibrin, and it is this fibrin which helps to localise an infected area by causing coils of intestine, omentum, etc., to become stuck together, thereby walling off the contaminated part from the rest of the peritoneal cavity. Free gas in large quantities often accumulates in the abdominal cavity in cases of perforation of the stomach or intestine. Small quantities of gas

may sometimes be manufactured by gas-forming organisms in certain localised intra-abdominal abscesses.

Cokkinis writes:

The exudate of peritonitis, although it helps by attacking bacteria and their toxins unfortunately becomes distributed over the peritoneal cavity, and so tends to disseminate the infection, unless localisation has already occurred. Infection can also be spread directly along the serous membrane, or by the peritoneal and extra-peritoneal lymphatics.

In the event of survival, *resolution* of the infection occurs by absorption of the exudate. Fibrin may also be absorbed, after phagocytic digestion, or it may be organised into fibrous adhesions. The worst type of adhesions are formed when parts of the peritoneal membrane have been completely destroyed by the inflammatory process, the granulation tissue which develops in the stage of repair giving rise to dense fibrous tissue. Intestinal obstruction may be produced by both fibrinous and fibrous adhesions, but while the first variety causes obstruction in a few days, the second may do so after an interval of years.

Not infrequently resolution is imperfect, and a localised *inflammatory mass* or tumour results. This consists of the inflamed viscus, perhaps with one or more coils of intestine, and portions of swollen omentum and mesentery, matted together by adhesions, which more or less entirely isolate the mass from the general peritoneal cavity. Such a mass may resolve completely, but it may also pass on to the formation of a *focalised abscess*.

Occasionally, this failure of resolution in diffuse peritonitis is a widespread phenomenon. Numerous pockets of pus are left, partly shut off by glued coils of intestine or by adhesions, while the peritoneum itself and parts of the intestine remain oedematous, congested, and friable. This condition may continue for weeks, and constitutes what some writers describe as "*chronic septic peritonitis*."... In these cases, a fatal result from chronic toxæmia, or from paralytic or adhesive ileus, is almost inevitable.

In cases of diffuse peritonitis important changes also occur in the *extra-peritoneal tissues*. The vessels become engorged, the lymphatics are inflamed, and oedema of the areolar tissue is produced by an extravasation of serous fluid into it. The most fatal cases of peritonitis (usually streptococcal) may show little evidence of peritoneal reaction or effusion; instead, the outstanding morbid change appears to be an intense and rapidly spreading *lymphangitis* of the extra-peritoneal lymphatics, not unlike erysipelas of the skin (*fulminating peritonitis*). In such cases the naked-eye findings at operation or post-mortem may be negligible.

Paralytic Ileus. Except in these fulminating cases, the most common complication of diffuse peritonitis is paralytic ileus. The great length and complete peritoneal covering of the small intestine exposes it in a marked degree to the inflammatory changes which affect all extra-peritoneal tissues. The intestinal

wall becomes congested and œdematous, and neuro-muscular mechanism responsible for peristalsis may, in consequence, be thrown out of action. Moreover, particularly in the early stages of peritonitis, the extrinsic sympathetic nerves of the intestine are likely to be irritated by congestion or œdema of the mesentery in which they run, and intestinal inhibition may also result from this cause.

"Peritonitic" ileus is thus produced by a combination of local action on the intestine and irritation of the inhibitory sympathetic nerves; there can be no doubt that it plays the major part in the morbidity of many cases of diffuse peritonitis, and is a contributory cause of death in all except the most fulminating ones.¹

TOXÆMIA OF PERITONITIS

Maybury and Williams (Choyce's *System of Surgery*, 2:466, 1932) believe that the lethal results of peritonitic ileus depend upon the absorption of *B. welchii* toxin from the stagnant contents of the distended intestine. There is no doubt that there is a marked increase in *B. welchii* and other anærobic bacilli in cases of obstruction of the intestine and that there is also a resemblance between the clinical manifestations of the last stage of peritonitis and that of severe anærobic infection.

Williams (*Brit. J. Surg.*, 14:295, 1926), as the result of his researches, attached the greatest importance to *B. welchii* toxæmia in intestinal obstruction and strongly advocated the use of anti-welchii serum in these cases. There has been a tendency of late to belittle the benefits which accrue from the use of this serum in combating severe intestinal toxæmia. Nevertheless, I feel sure that it has a definite place in the management of such cases. Holt (*Lancet*, 1:724, 1934), as the result of his investigations, maintains that the toxic symptoms of peritonitis and obstruction are caused by the absorption of toxic proteoses and of amino-acids from the obstructed and devitalised intestine.

It is perhaps true to state that whatever the source of intestinal toxæmia—and some maintain that it is probably non-bacterial in origin—there can be little doubt that the *immediate* cause of death in many instances of diffuse peritonitis is a bacterial toxæmia, the toxins being absorbed from the peritoneal cavity. The intensity of

¹ Cokkinis, *Postgraduate Surgery*, Medical Publications, Ltd., London, vol. 1, p. 1103, 1936

the toxæmia varies with the virulence of the organisms, the resistance of the patient and the success or failure of attempts at localisation.

THE CLINICAL PICTURE

In a fully established case of acute diffuse peritonitis the clinical manifestations are obvious and the condition, as it were, declares itself. But the onset and course will vary with individual cases and at different times in the same case.

The onset is sudden in cases of perforation, and this is followed by a distinctive intermediate latent interval which in turn gives place to the classical signs and symptoms of diffuse peritonitis. The onset is more gradual or insidious in non-perforative lesions and in certain post-operative cases. The clinical manifestations of the lesion responsible for the condition gradually merge into those of the first stage of peritonitis.

In the majority of cases an attack of acute peritonitis is clearly secondary and the condition responsible for it is obvious, *e.g.*, penetrating wound, recent operation, puerperal sepsis, etc., or readily diagnosed on physical examination, *e.g.*, appendicitis, salpingitis, gastric ulcer, etc. In others, there are no signs and symptoms of the causative lesion, this being found at exploratory operation or at post-mortem examination. Finally, in a few cases no obvious local cause can be found. There are the cases of so-called primary peritonitis of which streptococcal peritonitis is a classical example.

The course is variable. Some patients die within twenty-four to forty-eight hours from an overwhelming pyogenic toxæmia or septicæmia, while in some of the fulminating cases death may take place *within a few hours of the onset of the disease*.

At operation or autopsy little may be found except a quantity of clear or blood-stained peritoneal exudate or a spreading œdema of the retroperitoneal tissues. In the average untreated case death occurs between the third and seventh days, from toxæmia and paralytic distension of the intestines.

There is a large group of cases in which after a short stage of diffuse peritonitis the inflammatory process becomes localised either to the region of the causative lesion or to one of the dependent sub-phrenic compartments of the peritoneal cavity. The localised infec-

tion may either resolve completely or may terminate in a *residual abscess* which will require drainage at the opportune moment.

ANALYSIS OF EARLY SYMPTOMS AND SIGNS

The early symptoms do no more than suggest a diagnosis; the early signs confirm it. The importance of early diagnosis in cases of acute diffuse peritonitis cannot be over-stressed, as successful treatment depends so much upon the time factor.

Of all *symptoms*, pain is the most important and constant. It may, as I have said, be sudden or gradual in onset. It varies considerably in intensity. It may be, and often is, severe and unremitting, but at times it may be no more than a dull ache. In post-operative peritonitis, for instance, when the diagnosis is always difficult, pain may be so mild as to amount to nothing more than discomfort. In some cases, and more especially in feeble patients, pain may be entirely absent. Pain may be referred to the umbilicus or to that portion of the abdomen from which the infection originated, or it may be diffuse. It is, as a rule, most intense in that part of the abdominal wall which lies immediately over the spreading edge of the peritoneal inflammation. When the peritoneal infection subsides or localises, pain diminishes in severity and becomes limited to one area of the abdomen.

After operation in cases of peritonitis the gradual subsidence of pain is of good prognostic import; on the other hand, a continuance of pain, and particularly when this shows no response to sedative drugs, is an indication that the inflammatory process is not resolving satisfactorily. Collapse, which is so often seen after a viscus perforates, is due in the initial stages to peritoneal shock, while in the late phase it is caused by toxæmia. Vomiting may be slight at the start, but as the peritonitis advances it becomes persistent. At first only the stomach contents are voided, later the fluid which is brought up is bile-stained and brownish, while finally, when obstruction is complete, it becomes feculent. Vomiting may be absent or infrequent if fluids by mouth are withheld. In the early stage of peritonitis vomiting is reflex in origin, later it is probably toxic, but in the final stages it is due to paralytic ileus.

The temperature is often sub-normal or normal in cases in which

the onset is sudden, *e.g.*, perforated duodenal ulcer, but it tends to rise gradually as true peritonitis supervenes. It often falls rapidly in the terminal stage. It may rise when the causative lesion is inflammatory in character, *e.g.*, acute cholecystitis. In the fulminating cases the temperature may remain sub-normal throughout. A rising pulse-rate and a falling temperature are of the gravest significance; on the other hand, a gradually rising temperature and slowly falling pulse-rate suggest that localisation of the infection is taking place. The pulse remains normal for a few hours and is often weak from initial collapse. As the disease process advances, it steadily rises and becomes fuller and bounding, later on becoming weaker and more rapid. It is important therefore to take half-hourly records of the pulse-rate, as this will often indicate the true course of the disease.

The respirations from the start are quick, shallow, and thoracic in character, due to the immobility of the diaphragm. The tongue is furred but moist early in the disease, later becoming coated and dry. The bowels are usually constipated, although in some cases of pelvic peritonitis there may be diarrhoea.

The *signs* of early peritonitis are:

On inspection there is an absence or marked diminution of abdominal respiratory movements. The position of the patient in bed is often characteristic. He lies very still with the legs drawn up in an effort to relieve tension on the abdominal muscles. It will be noted that in the early cases there is marked retraction of the lower half of the abdomen.

On palpation tenderness and rigidity will be elicited. Tenderness is a constant but not such a reliable sign as rigidity. The tenderness is at first situated over the causative focus, but spreads with the diffusion of the peritoneal inflammation, which rapidly becomes generalised and extreme in degree.

There are two other signs which are constantly present: Rebound tenderness, *i.e.*, pain caused by sudden release of pressure of the examining hand; and pain experienced over the affected region by pressure on an uninvolved portion of the peritoneum. Of all signs rigidity of the abdominal muscles is the most reliable and important. It may be localised, as in some early cases where the peritoneal inflammation has involved only a limited area, or it may be generalised when the diffusion is extensive. The muscles are board-like in their

rigidity, but there are degrees in rigidity which can be distinguished by the hand of the expert. For instance, in thin and wasted patients it tends to be less marked, while in the aged and in those who have been over-drugged with opiates it may be slight or even absent.

On auscultation intestinal sounds are diminished from the outset. These may be absent over the area of greatest mischief, and in a well-established case of peritonitis with ileus there is often a sinister stillness. In mechanical obstruction there are, by contrast, loud splashing explosive sounds, peristaltic rushes, and tinkling bell-like sounds which are more pronounced over the actual site of the blockage. In all acute abdominal emergencies, therefore, the greatest importance is attached to an examination of the abdomen with a stethoscope.

On percussion the abdomen is everywhere resonant and tympanitic owing to the fact that the intestines are filled with gas. In certain instances, for example, following the rupture of a perforated peptic ulcer, liver dulness may be made out when the exudate is profuse, but this examination occasions a great deal of distress and pain.

THE PICTURE OF THE LAST FEW HOURS

A late stage is reached when the peritonitis has progressed for twelve to forty-eight hours or more, when the intestines have become paralysed and intensely inflamed and blown out with gas, and when the patient shows signs of toxæmia and ileus. It is the stage of despair and of lost hope. The clinical picture has already been portrayed in describing the final phase of an untreated perforated peptic ulcer (page 377), but a brief résumé of the salient features is here given in order to complete the story.

The pain now changes in character and becomes continuous and exhausting to a degree. Vomiting is no longer forcible, but is of the regurgitant type, profuse and effortless. The vomited material is dark, fæculent or of a sickly sweet odour. The pulse, which is full, bounding and rapid, becomes quicker and weaker. The temperature may be raised, but more frequently falls precipitously. Constipation is absolute; no flatus or fæces are passed. The face—the Hippocratic facies—tells at a glance that the end is near; the eyes are hollow, inquisitive and bright, the face mask-like, pale, pinched and blotchy; the brow and head are covered with cold perspiration; the lips are

blue, indicating circulatory failure; and the tongue is brown, dry and fissured. The whole body is icy cold and clammy, and the abdomen is distended, tympanitic, tender and rigid. On auscultation nothing can be heard except perhaps the transmitted feeble quickened heart beats. It is said that the mind remains remarkably clear to the end; this may be true in a number of cases, but in the majority it is muddled and clouded by the numerous drugs which are often so repeatedly injected in a vain attempt to allay restlessness or to stimulate the inert intestines to freshened activity. When renal and circulatory failure are evident, the battle for life is over.

DIFFERENTIAL DIAGNOSIS

The cardinal clinical manifestations of acute peritonitis are continuous abdominal pain, vomiting, a rising pulse-rate, rigidity of the abdominal muscles, spreading tenderness, diminution or loss of intestinal sounds on auscultation, and increasing distension. Some of these signs and symptoms are present in other abdominal diseases. In the early stages, acute peritonitis may be confused with the following:

1. **Certain Thoracic Diseases.** These are especially pleurisy and pneumonia. In these conditions pain may be referred along the intercostal nerves in the abdominal wall. The pain is influenced by respiratory movements and there is an alteration in the respiration-pulse ratio. As a rule, there is little or no abdominal rigidity, at least no true rigidity. Cope has shown that firm, deep pressure does not increase the pain as it does in peritonitis. There may be definite signs in the chest, but it is well to remember, as previously stated, that peritonitis and pulmonary disease may co-exist. If the pulmonary disease is unilateral, the referred pain is strictly limited to one side of the abdomen. Pericarditis and coronary thrombosis may suggest a diagnosis of perforated peptic ulcer or of fulminating acute cholecystitis, as both of these cardiac conditions may be associated with severe epigastric pain and involuntary muscular guarding. But these lesions are not the cause of true rigidity. They can be excluded by paying special attention to the history of the case, the mode of onset, and the cardiac symptoms, together with a routine examination of the chest.

2. **The Colics** (see pages 869, 903).

3. **Intestinal Obstruction.** In the early stages the differentiation is easy, as in intestinal obstruction there is colicky pain, and on examination little if any tenderness and rigidity on pressure. With the aid of the stethoscope, bowel noises will be heard in obstruction but not in peritonitis. Intestinal obstruction may, of course, lead to peritonitis, but when this stage is reached the picture is unmistakably that of peritonitis.

4. **Intra-Peritoneal Hæmorrhage.** If the bleeding is caused by some external violence, such as a kick in the abdomen, the diagnosis may be very difficult. There may, for instance, be rigidity and tenderness of the muscles owing to bruising and laceration; reflex vomiting may occur, and the pulse-rate may gradually rise. After a while, however, the clinical picture becomes that of intra-peritoneal hæmorrhage.

5. **Renal Disease.** Acute pyelitis and acute pyelonephritis may cause severe pain with localised rigidity and tenderness. These diseases, however, are associated with hyperpyrexia, rigors, and pus and organisms in the urine. A diagnosis of acute abdomen is never complete apart from an examination of the urine. In uræmia the intestines may slowly distend and fail to act, but the absence of abdominal rigidity and tenderness is proved conclusively.

6. **Spinal Cord and Column.** *Tabes dorsalis* and spinal caries with psoas abscess are two conditions which may at times prove misleading.

7. **Torsion of a Solid Organ.** These may consist of ovarian cyst, subserous fibroid, etc.

8. **Diabetes Mellitus with Hyperglycæmia.** Here there may be abdominal pain, accompanied by tenderness and rigidity, but the symptoms disappear when the blood sugar again approaches the normal.

It is easier to diagnose the presence than the cause of peritonitis. In summing up it may be said that when a patient gives a recent history of acute abdominal pain, such diseases as appendicitis, ruptured peptic ulcer, etc., should first be considered. In old patients, perforated diverticulitis and leaking cancer of the colon should not be forgotten, while in women with pelvic peritonitis, infection of the fallopian tubes and ovaries should be borne in mind. In female children the possibility of pneumococcal peritonitis should not be over-

looked, more especially when the abdomen is tumid rather than rigid.

TREATMENT

Prophylactic. It is often possible to prevent the onset of acute peritonitis. If, for instance, every acutely inflamed appendix or gall-bladder could be excised at the commencement of the attack, every bowel obstruction could be relieved at once, every operation upon the stomach or intestines could be carried out without spillage or leakage, and every perforation of a gastric, duodenal or jejunal ulcer could receive timely treatment, diffuse peritonitis would become a very rare disease. Again, as peritonitis may be caused by ascending infection of the genital tract—gonococcal or pneumococcal, the appropriate treatment of the vaginal infection will frequently prevent the extension of the infection to the peritoneum.

Curative. This is not necessarily synonymous with immediate operation. Although it is generally agreed that immediate operation should be performed on most cases in which acute diffuse peritonitis has been diagnosed and in which a local cause is known to be present or is suspected, there are nevertheless a few cases in which it is wiser to adopt palliative measures, at least for the time being.

Delayed treatment may, for example, be advisable:

1. In certain cases of acute appendicitis when the infection is definitely localised (page 891).
2. In gonococcal peritonitis (page 939).
3. In certain cases of pelvic peritonitis (page 939).
4. In primary peritonitis of children when any local cause can be excluded (page 936).
5. In moribund patients (page 935).

With the exceptions here cited, immediate operation is advised. But "immediate" should not be translated too literally. In many cases an hour or two may be profitably spent in planning so that the operation may be conducted under the best conditions possible, in repairing fluid loss by the intravenous injection of saline-glucose solution, and in relieving distension by aspiration of the gastric contents.

Operative measures include:

1. Removing or shutting off the source of the infection.

2. Cleansing the peritoneum when this is necessary.
3. Drainage of the infecting focus or of the peritoneum (if necessary).

The post-operative treatment is mainly directed toward:

1. Dealing with the paralytic ileus.
2. Antagonising the bacteria and their toxins.

OPERATION

The operation should if possible be performed under spinal anæsthesia. The advantages are:

1. That it tends to diminish paralytic ileus as it abolishes the inhibitory action of the irritated sympathetic nerves on the intestine.
2. That it ensures good relaxation of the abdominal muscles, thereby facilitating the search for and removal of the source of the infection.

Intravenous saline solutions or vasomotor stimulants such as adrenalin should be given if there is a marked fall of blood pressure during spinal anæsthesia. Spinal anæsthesia is contra-indicated in patients with low blood pressure, in those in whom the circulation is failing, in those in whom there is a condition of shock or collapse, and in children. In such cases operation is conducted under local anæsthesia, supplemented if necessary by gas and oxygen. Both chloroform and ether tend to increase the likelihood of paralytic ileus and are recognised as dangerous anæsthetics in the presence of a severe toxæmia, and it is for these reasons that they are not employed in cases of peritonitis.

The *incision* should be carefully planned and should be made so as to give ready access to the causative lesion. When the cause is known or suspected to be in the upper abdomen, *e.g.*, perforated peptic ulcer, the median vertical epigastric or right paramedian incision is chosen; when in the lower abdomen, a right paramedian incision is selected. If, for one reason or another, there are good grounds for suspecting the appendix to be the causative factor, McBurney's incision will suffice. In cases where there is doubt, a paramedian para-umbilical incision, one-third above and two-thirds below the umbilicus, is the best as it may be readily extended upward or downward according to the circumstances of the case.

Transverse incisions, transrectus muscle-split incisions and Battle's incision are best avoided when exploratory laparotomy is indicated in cases of diffuse peritonitis.

Throughout the operation the edges of the wound should be protected with sheets of cellophane gauze, and peritoneal exudate should be removed by suction. Both during the search for and treatment of the causative lesion the surgeon should exercise the most meticulous care and gentleness. He must handle the intestines daintily and as little as possible. Flakes of fibrin which may be deposited upon the intestines should not be detached, nor should evisceration be permitted at any time during the progress of the operation.

The surgeon should do no more than is absolutely necessary and he must do it gently and quickly. Nothing should be attempted except what is strictly essential to the patient's immediate recovery. All non-urgent operative procedures should be left over until some future date.

The actual procedure naturally depends upon the cause of the peritonitis. Thus, a perforation of the stomach, duodenum or intestine, whether pathological or traumatic, must be closed, a perforated appendix which has given rise to a diffuse peritonitis demands excision, gangrenous intestine must be resected or exteriorised, an acutely inflamed gall-bladder must be drained or removed, and so forth. An abscess rupturing into the peritoneal cavity must be drained by a separate incision, and an infective focus which can neither be removed nor closed, as for example acute hæmorrhagic pancreatitis, is best connected to the exterior by a drainage tube. Purulent peritoneal exudate should in all instances be evacuated, as it is toxic, it hinders the intestines from recovering their normal condition, and it may act as a culture medium for micro-organisms and thus favour re-infection of the peritoneum. Localised collections of pus should be mopped up cautiously with soft gauze swabs and any foreign bodies, such as fragments of food, fæcaliths, gall-stones, etc., which may be lying free in the peritoneal cavity, should be removed. Irrigation of the peritoneal cavity for cleansing purposes is never justified, even in the presence of gross fæcal contamination.

Great pains should be taken to avoid any injury to the delicate and inflamed endothelium of the parietal peritoneum or of the intestine. Such trauma may be caused by packing off the intestines

roughly, by stripping away flakes of adherent lymph, or by wiping purulent material off the surface of the gut with dry gauze swabs.

The peritoneum has great absorptive and recuperative powers, and in many cases after the initial cause has been removed or dealt with it may be trusted to look after itself in a highly efficient manner.

With regard to the vexed question of *drainage* in cases of peritonitis, it may be briefly stated that:

1. Drainage Should be Provided:

(a) When a localised abscess, *e.g.*, appendix abscess, increases in size or fails to resolve.

(b) When a necrotic viscus, *e.g.*, gangrenous gall-bladder, cannot be removed.

(c) When, following suture of a perforation, the closure does not appear to be safe and sound, *e.g.*, suture of a perforated gastric ulcer situated near the cardia, suture of a leaking carcinoma of the colon, etc.

(d) When, following the removal of an inflamed viscus, such as a gangrenous appendix or gall-bladder, a friable, semi-necrotic bed is left behind, or when, after such an operation, there is a persistent oozing of blood from the structures around which proves difficult to control.

(e) In cases of perforated diverticulitis.

(f) After insecure and doubtful suturing of intestine and other hollow viscera, *e.g.*, intra-peritoneal rupture of the urinary bladder.

(g) In cases of perforated peptic ulcer when frank peritonitis is present, *i.e.*, usually twelve hours after the onset of the perforation.

(h) In cases of general peritonitis due to perforated appendix owing to the copious and purulent character of the exudate.

2. Drainage Is Unnecessary and Possibly Harmful:

(a) In cases of primary streptococcal and pneumococcal peritonitis of children. Later, if loculated abscesses form, they should be incised and drained.

(b) In all those cases where the infecting focus has been excluded with certainty and there is no likelihood of the development of other infective foci, *e.g.*, suture of a perforated peptic ulcer within the first twelve hours of the onset of perforation.

(c) In cases of gonococcal peritonitis.

The drainage tube should be removed:

1. Within twenty-four hours when the tube is introduced with the object of draining the general peritoneal cavity, *e.g.*, supra-pubic drainage in cases of general peritonitis.

2. Within three to five days when the tube is inserted for the purpose of draining an actual or potential focus of infection, *e.g.*, appendix abscess.

POST-OPERATIVE MANAGEMENT

The aims of post-operative treatment are:

1. To maintain nutrition and a satisfactory chemical balance.

2. To prevent the onset of paralytic ileus and to treat it when it is present.

3. To treat the peritonitic toxæmia.

The treatment during the first forty-eight hours is the same for most cases:

1. Morphia, gr. $\frac{1}{6}$, is injected every six to eight hours to secure mental and physical rest.

2. Heat is applied to the whole abdomen by means of a radiant heat cradle, electrically heated pads, hot compresses, etc.

3. No fluids are given by mouth or introduced into the rectum. The abolition of intestinal movements ensures rest to the inflamed peritoneum and tends to diminish the spread of infection.

4. Fluids, sugar, salt, alcohol, etc., are given by the intravenous route. In patients with general peritonitis the chemical balance is nearly always seriously deranged and dehydration and depletion of the sugar and salt reserve are common. It is most important that these deficiencies should be corrected without delay. Frequent chemical and other examinations of the blood are therefore required. A saline-glucose solution should be run into a vein by the slow drip method, but it is well to remember that there is a real danger of administering excessive amounts of salts, as Maddock and Coller (*J. Am. M. Ass.*, 108:1, 1937) have emphasised. Sterling Mueller (*Surg. Clin. N. Am.*, 19:401, 1939) has found the infusion of 5 per cent or 10 per cent alcohol in saline or glucose-saline solution to be of particular help in cases of severe peritonitis, especially when accompanied by paralytic ileus. He advises the addition of vitamin B₁ and cevitamic acid to the infusion when no fluid is being taken

orally for a period, as he believes that the body requirement of water-soluble vitamin is increased when intensive therapy is being pushed. Mueller also advises that absolute alcohol be added to the solution, which should be shaken up to prevent layering, and a 5 per cent concentration of the alcohol in about 2,000 cc. saline solution be produced.

Mellanby estimated that a normal individual could oxidise per hour 10 cc. of alcohol if given orally. From this it was inferred that 100 or even 150 cc. was not an excessive amount of alcohol to give in twenty-four hours by the continuous drip method. In practice, however, not more than 100 cc. in each twenty-four-hour period is given. The 5 per cent or 10 per cent solution of alcohol has no particular sclerosing effect upon the veins beyond that found with the usual intravenous solutions. When alcohol is given intravenously, no after-effects are observed—no acidosis, no headaches, and no vomiting or nausea such as may result when equivalent quantities are taken by mouth. In this way the sedative effect of alcohol may be used to advantage. No untoward symptoms were observed by Mueller in its use in a series of 2,000 infusions.

5. Whole blood transfusions are given to all severe cases as a routine measure. The giving of blood to toxæmic patients has proved invaluable.

6. Intestinal decompression is achieved by Wangensteen's method (*Tr. West. Surg. Ass.*, 1931; *West. J. Surg.*, 40:1, 1932; and Wangensteen and Paine (*J. Am. M. Ass.*, 101:1537, 1933) or by means of the Miller-Abbott tube. Intestinal decompression by an indwelling duodenal tube is more effective than enterostomy and has none of its risks. The Miller-Abbott tube acts like a charm once its bulbous end has successfully negotiated the pyloric canal. It may take a few hours to pass into the duodenum, but once it has done so it works in a most efficient manner.

7. Fowler's position. As soon as the patient has recovered from the anæsthetic he is propped up and gradually placed in the high Fowler position so as to encourage the toxic exudate to gravitate toward and pool in the pelvic cavity.

8. Specific treatment. At operation specimens of the peritoneal exudate should be taken and examined. If the peritoneal exudate shows the presence of:

(a) *B. welchii*—a concentrated solution of anti-gas gangrene anti-toxin should be injected intravenously or intramuscularly.

(b) Pneumococci—typed anti-pneumococcal serum should be given and full doses of sulphapyridine also prescribed.

(c) Streptococci—anti-streptococcal serum is sometimes effective. Sulphanilamide therapy should be given a trial.

Smith (*Am. J. Surg.*, 19:272, 1933) claims good results with *bacteriophage*. It is either administered by a catheter which is passed through the operative wound, or it is simply injected through the drainage tube. The usual dose is 30 to 60 cc. of autogenous or mixed anti-coli, anti-streptococci and anti-staphylococci bacteriophage. It is best to give a full dose at the completion of the operation and to repeat this daily for a few days. After the introduction of the bacteriophage, the tube should be clamped for about six hours in order to encourage diffusion.

Treatment After the First Forty-eight Hours. Morphia, gr. $\frac{1}{8}$, twice or thrice daily, duodenal drainage, heat to the abdomen and intravenous fluids are continued. A flatus tube is passed from time to time. Toward the close of the second day the abdomen is examined with a stethoscope and if peristaltic sounds are heard 1 cc. of pituitrin is injected intra-muscularly and about 10 minutes after this a glycerine enema is given. If flatus is passed, the post-operative treatment will be conducted on the usual lines, i.e., no purgatives by mouth, 0.5 to 1 cc. of pituitrin every eight to twelve hours, and a daily enema until a normal evacuation has been obtained.

If, however, following the initial injection of pituitrin and the administration of the first glycerine enema no flatus is passed, it becomes imperative to ascertain without delay whether the intestines are, in fact, capable of stimulation. If peristaltic sounds are clearly audible on auscultation it is probable that the following measures will at this stage prove successful: pituitrin 0.5 cc., eserine, gr. $\frac{1}{64}$, and acetylcholine, 0.2 gm., are shaken up in a syringe and injected hourly for four doses; after the final injection an ox-bile, glycerine or molasses enema is administered very slowly, this being followed half an hour later by a simple or turpentine enema. If flatus is passed, the "stimulant" treatment should at once be relaxed. If, however, all the above measures fail, *no further attempt* should be made to flog the inert intestines by repeated injections of the so-

called constrictor drugs and by copious enemata. We must, in fact, return to our original methods of rest with the aid of morphia, of heat to the abdomen, and of fluids intravenously in order to preserve a normal water balance. We can do little more than wait and hope at this most critical stage, since the unremitting use of pituitrin and allied drugs does more to poison the patient than to induce the crippled gut to force its gaseous contents forward. Concentrated salt solution (10 to 20 per cent) more readily clogs up a valuable vein than kindles the contractile power of the intestine; spinal anæsthesia may abolish sympathetic activity, but it sends a flagging blood pressure careering downward to a level hardly compatible with life; while operation—the last resort of a desperate surgeon—adds yet another unnecessary torture to an already harassed and sinking patient without achieving anything worth while. If the cause of the peritonitis has been dealt with in a thoroughly efficient manner at the first operation, we cannot hope to improve matters by re-opening the belly, seeing that the patient is dying from paralytic ileus. It is futile to perform enterostomy or any type of short-circuiting operation when the intestines are paralysed beyond all hope of recovery.

CHAPTER 2

SPECIAL TYPES OF PERITONITIS

PRIMARY STREPTOCOCCAL TYPE

The term "primary" is given to those cases of acute peritonitis in which no obvious intra-abdominal cause can be found. Primary streptococcal peritonitis is a rare but extremely fatal disease with a mortality of about 80 per cent. Barrington-Ward (*The Abdominal Surgery of Children*, 1937) states that in the last twenty years at the Hospital for Sick Children there were 21 cases of streptococcal peritonitis, 12 of whom were operated upon and all of whom died. Bruce and Logie (*Brit. M. J.*, 1:270, 1933) reported 8 cases, three of whom recovered after operation. Pollock (*Arch. Surg.*, 33:714, 1936), in a review of 42 cases which were treated at Mount Sinai Hospital during a period of eleven years, recorded 9 recoveries, six of which were treated surgically and three medically.

Primary streptococcal peritonitis is especially a disease of infancy and childhood, but it may occur in adult life and involves the sexes equally. The origin of the peritonitis is most frequently an acute infection of the upper respiratory tract, *e.g.*, acute pharyngitis. Many cases have been observed during epidemics of streptococcal tonsillitis (Capps and Miller; *J. Am. M. Ass.*, 58:1848, 1912), and some cases have been seen in which the condition complicated erysipelas (Pflaum; *J. Missouri M. Ass.*, 30:72, 1933), scarlet fever (Kogis and McCabe; *Am. J. M. Sc.*, 185:710, 1933), or nephritis (Lazarus; *Am. J. Surg.*, 34:70, 1932). In nearly every instance the peritonitis is a local manifestation of septicæmia and the infection reaches the peritoneum by the blood stream. As might be expected, blood cultures are frequently positive. Cokkinis (1936) remarks that it is a striking fact that while secondary peritonitis usually starts as a localised condition and becomes generalised, the primary variety begins as a diffuse inflammation and becomes localised (if the patient lives long enough).

Diagnosis. This is always a difficult problem.

The reason lies in an inability to obtain an accurate subjective history, the difficulty in making a reliable physical examination and the frequency with which irregular complaints referable to the abdomen accompany infections of the upper respiratory tract, gastro-intestinal upsets, and acute infectious diseases in young children. As a result of a tendency to minimise or ignore abdominal discomfort under these conditions, advanced peritonitis not infrequently exists by the time the child is brought to the hospital.¹

The main symptoms are constant abdominal pain, vomiting and diarrhoea. In some cases pain may be slight. Diarrhoea with greenish watery stools is a common feature. The signs of a grave intoxication are shown by a rapid pulse, restlessness and sunken features, and there is often a high swinging temperature. The abdomen is usually uniformly distended, tender and tumescent; but there is little or no true rigidity. Evidence of fluid can sometimes be elicited. The white cell count varies, leucocytosis is a common finding. In the most fulminating cases there may be a leucopenia.

The following conditions must be considered in the differential diagnosis: (1) primary pneumococcal peritonitis; (2) acute diffuse peritonitis of appendicular origin; (3) acute exudative tuberculous peritonitis; (4) acute gastro-enteritis; (5) acute mesenteric lymphadenitis; (6) enteric fever.

In doubtful cases abdominal puncture and aspiration of the peritoneal exudate may be of the greatest value in diagnosis through the discovery of large quantities of Gram-positive streptococci with pus cells on microscopical examination of the smears.

Treatment. When the diagnosis appears to be reasonably assured, or when the patient is so gravely ill that any exploratory operation would be fraught with extreme danger, it is best to treat the patient on medical lines which would include such measures as continuous intravenous infusion of saline-glucose solution, repeated transfusions of blood, injections of anti-streptococcal serum, and the administration of sulphanilamide or sulphapyridine, on the lines suggested by Banks (*Lancet*, 1: April, 1939).

Should localisation fortunately occur, any large walled-off abscesses should be incised and drained.

In a number of cases it is impossible to arrive at a pre-operative

¹ Pollock, *Arch. Surg.*, 33 714, 1936.

diagnosis, and operation is carried out with the object of ascertaining the causative factor. Here a median, sub-umbilical incision should be made, through which the pelvic viscera, the appendix, etc., can be thoroughly examined. In the absence of any primary infective focus the case is assumed to be one of primary peritonitis.

The surgeon has a choice of two procedures:

1. To evacuate the toxic exudate by means of suction or by mopping out the fluid with swabs, and after this to insert a drainage tube; or

2. To leave the effusion alone and to close the abdominal wound completely, deferring drainage (if required) until a later date. My own preference is for the second procedure rather than for the first.

PNEUMOCOCCAL TYPE

Pneumococcal peritonitis may occur as a "primary" infection or secondary to a pneumococcal septicæmia, pneumonia or some upper respiratory tract infection. McCartney and Fraser (*Brit. J. Surg.*, 9:479, 1921) estimated that about 2 per cent of the abdominal emergencies in children were due to pneumococcal peritonitis. The majority of cases which occur in girls are of the primary type, while most of the cases seen in boys are secondary. According to Horine (*Ann. Surg.*, 102:391, 1935) less than one-third of all cases are of the secondary variety.

1. **Primary Pneumococcal Peritonitis.** This starts as a pelvic peritonitis, and it is generally believed that the infection is conveyed through the genital passages. In the first stage of the disease the fluid which collects is serous, turbid and odourless, being creamy, greyish-yellow or greenish-yellow in colour. In the intermediate stage the exudate becomes frankly purulent, but the peritoneum is not always hyperæmic although it becomes so at a later stage. The intestines, which become bathed in this fluid, have a slippery and slimy feel. During the third stage of the disease the exudate, which is now much thicker, contains many flakes of lymph, and localised abscesses form as the result of the adhesive material which binds the intestines together.

The onset is sudden, with pain in the lower abdomen, vomiting, hyperpyrexia, rapid pulse, cyanosis and prostration. Diarrhœa and

frequency of micturition are common symptoms owing to the irritation of the pelvic peritoneum. On occasion there may be rectal tenesmus, and blood-stained mucus may be passed. On examination the abdomen will be found to be distended and tender, and although the muscles are not necessarily rigid they are slightly on guard. The white cell count is high (30,000 to 40,000) and blood cultures are frequently positive.

2. Secondary Pneumococcal Peritonitis. This may occur at any age, although it is most commonly seen in children as a complication of pneumococcal septicæmia, pneumonia, or a throat or middle ear infection. The peritonitis may develop during the active phase or more usually a few days after the primary focus has shown signs of subsiding. The clinical manifestations, which are those of a diffuse peritonitis, may be masked by the intensity of the general illness and accompanying toxæmia.

Diagnosis. The diagnosis has to be made from other varieties of peritonitis, and more especially that of appendicular origin. One diagnostic point of great clinical value is peritoneal aspiration and the finding of creamy odourless pus containing Gram-positive extracellular diplococci.

According to all published figures, the *prognosis* is bad. Thus Barrington-Ward (1937) reports a mortality of 74 per cent, while Auroseau (1928), Loewe (1937), Budde (1926) and Daviond and Mathieu (1929) record a death-rate varying from 75 per cent to 95 per cent. McCartney and Fraser (1921) claim a reduction from 65 per cent to 42 per cent.

Treatment. The treatment at first is conducted on conservative lines, and later, if the infection becomes circumscribed, the abscess or abscesses should be opened and the pus evacuated. If the diagnosis has been confirmed by peritoneal puncture, operation during the early stages is definitely contra-indicated. If perchance the surgeon finds it impossible to exclude appendicitis and decides to operate, he should, on discovering that he is dealing with a case of diffuse primary peritonitis, close the abdominal incision as quickly as possible. Laparotomy can be advised only if there is real doubt as to the nature and origin of the peritonitis. If an exact diagnosis of pneumococcal peritonitis has been reached, the general measures applicable to all cases of peritonitis should be employed, together with

specific treatment with typed anti-pneumococcal sera and sulphapyridine. The patient should thus be nursed in the sitting position, heat should be applied to the abdomen, no fluid nourishment should be given by mouth, no purgatives administered, blood transfusions given as often as is deemed advisable, glucose-saline solution run into a vein by the slow drip method, and morphia not withheld.

Treatment with M. & B. 693—the non-proprietary designation is sulphapyridine—constitutes a real advance in the management of these cases, and has yielded brilliant results, as Barnett, Hartmann, Perley and Ruhoff have shown.

They write:

This type of pneumococcal infection, next to that of meningitis, lends itself the most easily to the evaluation of a type of therapy. Particularly when it occurs in patients with active nephrosis or chronic nephritis with marked nephrotic tendency, in which cases it is so common and so often fatal, it can very readily be diagnosed by abdominal paracentesis; treatment may be instituted early and the course of the disease followed bacteriologically by subsequent abdominal paracenteses. In the two cases of this sort that we have treated, Patient 19 with sulphapyridine alone and Patient 20 by a combination of the drug and anti pneumococcus rabbit serum, the results were very satisfactory. The control of the infection in the first patient, as contrasted to the usual stormy course that these children have if they do survive, is most striking. No less so is the clinical course of Patient 21 who had a primary pneumococcal peritonitis with septicemia.²

The following dosage of M. & B. 693 is suggested for cases of pneumococcal peritonitis in children:

Age	1 3 mth.	6 mth. to 2 yr.	3 yr.	5 yr.
Dose in tablets	0.125 gm. 4 hourly	0.25 gm. 4-hourly	0.375 gm. 4-hourly	0.5 gm. 4 hourly _e

For a child of, say, 10 years of age, I would recommend 1 gm. every four hours. In all cases the first one or two doses should be twice the recommended quantity. When oral medication is difficult on account of vomiting, treatment should be initiated by injections of solution of the sodium salt of M. & B. 693 in half the oral dose at the same intervals of four hours, either intramuscularly or intravenously, oral

² Barnett, Hartmann, Perley and Ruhoff, *J. Am. M. Ass.*, 112 515, 1939.

administration being resorted to as soon as the degree of clinical improvement renders this practicable.

GONOCOCCAL TYPE

In almost every instance the peritonitis is limited strictly to the pelvis. It is most exceptional to find the whole peritoneal cavity involved, but this may, nevertheless, occur in gonoccal septicæmia. A few cases of gonococcal pelvic peritonitis have been reported in males and it has here been assumed that the infection originated in the seminal vesicles. In women the infection is an ascending one, but the local irritation of the pelvic peritoneum is at first aseptic in nature, as the gonococci are confined to the mucosa of the fallopian tubes. Actual multiplication of gonococci on the surface of the peritoneum, however, takes place at quite an early stage in the fulminating cases.

The onset is sudden with continuous pain in the lower half of the abdomen, accompanied by sharp attacks of vomiting. The patient will often complain of scalding pain on micturition, frequency and even strangury.

On physical examination the abdomen is found to be distended in its lower half and there are marked tenderness and rigidity of the hypogastrium and in both lower quadrants. The vulva is inflamed and œdematous, there is a vaginal discharge of creamy yellowish pus, and marked tenderness in the fornices. After a few days the inflammation slowly subsides, but strong adhesions form which bind the pelvic viscera together and eventually give rise to chronic backache, lower abdominal pain and much ill-health. Erosion of the cervix, chronic salpingo-oophoritis, cystitis, etc., are common sequelæ.

Treatment. This is conducted along conservative lines, and the following measures may be adopted: Fowler's position, continuous heat to the lower abdomen, injections of morphia as required, hot vaginal douches, intravenous infusions, and the administration of sulphathiazole, which often acts as a specific.

TUBERCULOUS TYPE

This is an inflammatory condition of the peritoneum caused by infection with the tubercle bacillus. In some 30 to 40 per cent of

cases the organism is of the bovine type. Tuberculous peritonitis is essentially a disease of childhood, although no age is exempt. According to Kellett (*Brit. Encycl. Med. Prac.*, 9:557, 1938), the majority of cases occur between the second and fifth years of life, and most of the deaths during the second and third years. In childhood the sexes are equally affected. The earlier the appearance of the tuberculous peritonitis, the worse the prognosis. As might be expected, the death-rate in untreated cases is very high; but combined medical and surgical measures will probably effect a cure in nearly half the cases.

The infection may spread to the peritoneum from a tuberculous fallopian tube, a tuberculous mesenteric gland, a tuberculous ulcer of the ileum, a tuberculous appendix or cæcum, a contiguous psoas abscess or from a tuberculous lesion in the urinary tract (Comby; *Arch. de méd. d. enf.*, 39:761, 1936). In some instances, and more especially in phthisis, the organism may be brought to the peritoneum through the blood stream, in which event the infection is likely to be generalised.

In most cases the parietal and visceral peritoneum become studded with innumerable small tubercles and a large quantity of straw-coloured fluid is poured out into the abdominal cavity. In some of the more chronic cases this fluid is gradually absorbed, and widespread adhesions form between the diseased surfaces of the viscera and parietal peritoneum.

The following varieties are recognised:

1. Acute tuberculous peritonitis.
2. Chronic tuberculous peritonitis: (a) wet, serous or ascitic type; (b) adhesive or dry type; (c) encysted type; (d) ulcerative or fistulous type.

In the *acute* cases there is a high remittent or intermittent pyrexia, often with chills. There is also rapid wasting, loss of appetite, vomiting, abdominal discomfort, and a progressive distension of the belly. There may be diarrhœa or constipation, or diarrhœa alternating with constipation.

On examination, the extreme wasting of the face, neck, chest, and upper and lower limbs is a striking feature when compared with the abdomen, which is full, dome-like, and tense with free fluid. In male children this fluid may find its way to and distend a patent funicular process, resulting in the formation of a congenital hydro-

cele. There is some tenderness and rigidity over the whole of the abdomen, and the spleen and liver may be palpable. Leucopænia is a common feature.

The prognosis is grave, and tuberculous meningitis or generalised military tuberculosis is a common complication.

In cases of *chronic* tuberculous peritonitis, the onset is insidious and there are anorexia, low-grade pyrexia and loss of weight and of strength, and the general health shows marked deterioration. A blood examination frequently shows a leucopænia with secondary anæmia.

The following varieties are encountered:

1. The ascitic type, which is the commonest and in which the abdomen slowly and almost painlessly distends with free fluid.

2. The adhesive type in which, following the absorption of fluid, there is the formation of numerous adhesions resulting in the matting together of coils of intestines. These intestines may be bound together or to the abdominal wall, and there may also be "rolling up" of the omentum. In this type, small-gut obstruction is very apt to occur.

3. The encysted type. This is sometimes seen in the later stages when there may be one or more localised collections of serous fluid or circumscribed abscesses.

The ulcerative or fistulous type. Here there is the development of internal fistulæ, which produce communication between various viscera; and of external fecal fistulæ. Fæcal fistulæ are more often seen in the region of the umbilicus, but they may occur at the hernial orifices.

Diagnosis. The diagnosis is often difficult on account of the great variety in the symptoms and signs. The following investigations may be required:

1. Complete examination of the blood, including Wassermann reaction, blood culture and Widal test.

2. Mantoux test. This is certainly more helpful in the chronic than in the acute forms.

3. Examination of the fæces for tubercle bacilli, etc.

4. X-ray examination. Lakin attaches the greatest importance to a barium meal examination of the gastro-intestinal canal. He says that when the mesentery is contracted, intestinal coils are apt to be arranged in festoons, and as the opaque medium tends to lie in pools

at the bottom of the loops a number of fluid levels are characteristically seen. Straight X-ray pictures will sometimes reveal the presence of calcified or partially calcified lymphatic glands, and after the peritoneal cavity has been filled with oxygen an X-ray examination may demonstrate fluid exudates, enlarged glands, and even stout bands or adhesions.

5. Peritoneal puncture. If ascites is present some of the fluid may be aspirated for guinea-pig inoculation.

Treatment. Medical treatment, which should preferably be carried out in a sanatorium, is advisable for most of the cases. The patient should be confined to bed and be nursed in the open air, or at least in airy surroundings. Sunlight is of great advantage. Ultra-violet therapy may be helpful, while deep X-ray treatment by an expert may prove of value in suitable cases. The diet should be attractive and nourishing and should contain large quantities of fat and essential vitamins. Vitamins are best prescribed in the form of malt and cod-liver oil, halibut-liver oil and fresh lemon and orange juice. The bowels will require careful attention, as some patients suffer from diarrhoea while others are constipated or even have mild attacks of obstruction. A course of injections with tuberculin (T.R.) is recommended by some authorities, more especially where in the ascitic form of the disease laparotomy has been performed.

Surgery may be required:

1. To establish a diagnosis.
2. To relieve acute intestinal obstruction.
3. To deal with a perforation.
4. To drain a localised collection of serous or sero-purulent fluid.
5. For those cases of tuberculous ascitic peritonitis in which there are no signs of improvement after five to six weeks of intensive medical treatment. Operation should not be undertaken when there is evidence of phthisis, nor is it here wise to attempt treatment of a faecal fistula by surgical measures, as in such cases extensive peritoneal adhesions are present and the intestines are too soft, oedematous and friable for manipulations. It is universally agreed that the best results of surgery are seen in the ascitic cases. Here the abdomen should be opened through a median, sub-umbilical incision, the free fluid should be evacuated by means of suction, a search should be made for a primary focus of infection and if one is found it should

be excised if possible. The incision should then be closed without drainage.

As would be expected, the *prognosis* is most favourable in those cases where a local cause can be found and is capable of removal. For instance, some of the best results are seen in the ascitic cases where, on exploration, salpingectomy or salpingo-oophorectomy has been performed for tuberculous disease of a fallopian tube.

CHAPTER 3

SUB-PHRENIC ABSCESS

Signs of pus somewhere, signs of pus nowhere else, signs of pus there (Barnard).

Sub-phrenic abscess is without doubt one of the most important and interesting of all localised suppurations which occur within the abdominal cavity. It is primarily a complication of an intra-abdominal suppurative process. The pathology of the condition is complicated by the intricacy and the multitudinous anatomical arrangements and connections of the sub-diaphragmatic region. Diagnosis is difficult. This is in part due to the inaccessibility of the sub-phrenic region and to neglect to consider the possibility of sub-phrenic abscess in the individual case.

The treatment is associated with special difficulties of surgical access and particularly with the grave dangers of traversing the uninfected pleural and peritoneal cavities. The treatment of sub-phrenic *infection* is conservative, the treatment of sub-phrenic *abscess* is drainage.

HISTORICAL NOTE

The clinical features of sub-phrenic abscess were first described by Barlow (*Lond. M. Gaz.*, 1845) and later by von Leyden (*Ztschr. f. klin. Med.*, 1:320, 1880). Martinet's original, accurate and detailed anatomical description of the sub-phrenic spaces proved to be of the greatest assistance to Barnard (*Brit. M. J.*, 1:429, 1908) when he was making his investigations into the pathology, ætiology and treatment of sub-phrenic abscess at the London Hospital. Barnard's classical paper has formed the basis of practically every subsequent contribution to this subject and has been widely quoted by such authorities as Moynihan, Alton Ochsner, Pauchet and Fifield. In recent years Fifield and Love (*Brit. J. Surg.*, 13:683, 1926), Elkin (*J. Am. M. Ass.*, 97:1279, 1931), Beye (*J. Thoracic Surg.*, 1:655, 1932), Ochsner (*In-*

ternat. Clin., 2:79, 1931) and Ochsner and Graves (*Ann. Surg.*, 98:961, 1933) have written comprehensive reviews on this all-important subject. Von Volkmann (1879) performed the first operation for sub-phrenic abscess, whilst Trendelenburg (1883) was the first to introduce the transpleural approach. The greatest credit is due to Ochsner for perfecting the technique of retroperitoneal drainage, thereby drastically reducing the appalling mortality in cases of sub-phrenic abscess.

ANATOMY

A knowledge of the anatomy of this region is essential, both for a clear conception of the ætiology and pathology of sub-phrenic abscess and for an appreciation of the main factors concerned in its treatment (see fig. 201 [2] which diagram shows anatomical relationships of four types of these abscesses).

The liver divides the area between the diaphragm above the transverse colon and the mesocolon below into the supra-hepatic and infra-hepatic spaces respectively. The coronary ligament divides the supra-hepatic space into right and left regions. The right portion is divided by the right lateral ligament into two spaces: an anterior one and a posterior one. In the supra-hepatic region there are therefore three spaces: the right anterior superior, the right posterior superior, and the left superior. The infra-hepatic area is likewise divided into three spaces and into right and left portions by the ligamentum teres: the right inferior space is to the right of this ligament, and the left anterior inferior and the left posterior inferior space, separated from one another by the stomach and gastrohepatic omentum, are to the left. Retroperitoneal abscesses may also dissect upward between the diaphragm and the diaphragmatic peritoneum and thus become retroperitoneal sub-phrenic abscesses.

The most frequently involved space is the right posterior superior one. Thus, according to Ochsner and De Bakey (*Internat. Abstr. Surg.*, 66:426, 1938), in a collected series of 1,401 cases, the right posterior superior space was involved in 33.7 per cent. The reason given for the greater frequency of involvement in this space is the greater accessibility to inflammatory exudate tracking upward from the right iliac fossa along the right paracolic groove. The next most frequently involved spaces are the left inferior anterior and the right

superior. Extraperitoneal sub-phrenic abscesses are rare and occur in only from 7 to 15 per cent of cases.

ÆTIOLOGY

Up to the present date the total number of recorded cases is close upon 4,000. Sub-phrenic abscess is commoner in males (70 per cent) than in females (30 per cent), and is encountered most frequently in the third, fourth and fifth decades of life, the highest incidence being in the fourth. In about 85 per cent of cases sub-phrenic abscess follows a suppurative process within the abdominal cavity, and more than 60 per cent result from suppurative lesions of the appendix and from acute perforations of peptic ulcers of the stomach and duodenum. The next most frequent cause is acute cholecystitis and operations upon the gall-bladder and biliary passages, although operations upon the stomach, large gut and pelvic organs account for quite a few cases. Rarely sub-phrenic abscess may be caused by trauma, by extension of infection from the thorax into the sub-phrenic space, or even by infection through the blood stream. Ochsner and De Bakey have estimated that sub-phrenic abscess occurred as a complication of acute appendicitis in about 0.9 per cent of approximately 15,000 collected cases. Lesions of the appendix, gall-bladder and duodenum produce about 80 per cent of the sub-phrenic abscesses which occupy the right side, while the left-sided abscesses are most frequently caused by lesions of the stomach, such as perforated gastric ulcer, or following gastrectomy.

PATHOLOGY

Probably not more than 30 per cent of cases of sub-phrenic infection proceed to abscess formation. This is possibly due to the fact that the peritoneum of the upper abdomen is gifted with exceptional powers to cope with and overcome infection with bacteria.

The bacteriology of sub-phrenic abscess closely resembles that of diffuse peritonitis. The colon bacillus (40 per cent), streptococcus (40 per cent) and staphylococcus (20 per cent) are the organisms most frequently found in the pus from a sub-phrenic abscess. The infection is often mixed.

As would be expected, the morbid anatomy is that of any localised intra-abdominal suppuration. The size of the abscess is to some extent determined by the limits of the extension of the space in which it forms. Although the various spaces intercommunicate, the abscess tends to limit itself to one of them, since the communications are walled off by adhesions at an early stage in the infective process. The only common example of suppuration in more than one space is seen in the combined involvement of the right posterior superior and the right inferior intraperitoneal spaces in infections of appendicular or gastro-duodenal origin.

In untreated cases a small abscess may resolve completely and leave behind only a few adhesions; but the majority of the larger ones rupture into the pleura, the lung, the pericardium or the general peritoneal cavity. In some rare cases an abscess may rupture into an adjacent hollow viscus or erode the abdominal wall and burst on to the surface.

Thoracic complications may, of course, occur without rupture of the abscess through the diaphragm. An irritative serous pleurisy is an early manifestation of sub-phrenic abscess but such grave complications as empyema, pneumonia, pulmonary abscess, gangrene of the lung, broncho-pleural fistula or suppurative pericarditis occur late in the course of the disease and are therefore attributable to delay in diagnosis and in treatment.

MECHANISM OF THE SPREAD OF INFECTION TO THE SUB-PHRENIC SPACES

This varies according to the position and the nature of the original lesion. In a general way it may be stated that these routes of extension are sometimes through vascular channels from neighbouring or distant foci, but more frequently through intraperitoneal or extraperitoneal direct invasions or lymphatic drainage.

Bacteria may gain entrance to the sub-phrenic spaces in a number of different ways:

1. Local invasion by micro-organisms from lesions in the immediate vicinity.

2. Peritoneal exudate from distant portions of the peritoneal cavity, e.g., the right iliac fossa, may drain into the sub-phrenic region. Eisendrath (*Surg. Clin. N. Am.*, 1:1035, 1917) was one of the first to

suggest that infection might extend from the right iliac fossa along the paracolic gutter and so enter the sub-phrenic space.

3. Retroperitoneal phlegmon. As a result of invasion of the retroperitoneal cellular tissues, a phlegmon extending upward to the extraperitoneal sub-phrenic area may occur.

4. Retroperitoneal lymphangitis. Munro (*Ann. Surg.*, 42:692, 1905) held the view that infections might extend through the retroperitoneal lymphatic channels to the sub-phrenic spaces.

5. Lymphangitis of the lymph vessels accompanying the deep epigastric artery (Barnard).

6. Rupture of a liver abscess into the sub-phrenic space.

7. Trauma, *e.g.*, gunshot wounds of the liver.

8. Spread via the blood stream, *e.g.*, as in pyæmia.

DIAGNOSIS

The difficulty of early diagnosis of sub-phrenic abscess has been emphasised by all who have written on the subject. According to Cokkinis, the following are the chief reasons for delay in diagnosis:

1. The position of the abscess—deep and inaccessible.

2. The wide variations in the clinical manifestations.

3. The masking of the initial features of the abscess by signs and symptoms of the causative lesion. The picture may also be confused by the presence of intra-thoracic inflammatory complications.

4. Failure to think of sub-phrenic abscess as a possibility.

Delay in diagnosis obviously entails delay in treatment and also a greater likelihood of the supervention of thoracic complications—the main cause of death. The possibility of sub-phrenic abscess must be considered whenever the general evidence of sepsis disturbs the post-operative course of an abdominal case. After carefully ruling out the more common complications, such as infection of the wound, intra-thoracic suppurative processes, acute pyelitis and the pocketing of pus in the pelvis or in the paracolic gutters, we must think of the possibility of an abscess "*there*"—underneath the diaphragm.

CLINICAL VARIETIES

It is sometimes possible to recognise three clinical types:

1. In the *first type* the onset is sudden, the symptoms are acute, and the course of the disease is very rapid. The picture is that of a general peritonitis slowly subsiding and gradually merging into a localised collection of pus in the region of the liver. The causative lesion in this type is generally a ruptured peptic ulcer, a perforated appendicitis or the perforation of a gangrenous gall-bladder.

2. In the *second type* the onset is insidious, the symptoms are comparatively mild and the course of the disease is more gradual. Here the abscess beneath the diaphragm develops slowly following an obscure non-perforative infective lesion of one of the abdominal viscera, e.g., appendix. In Whipple's series (*Am. J. Surg.*, 40:1, 1926) there were 40 per cent of cases of this type.

3. In the *third type* are cases of post-operative sub-phrenic abscess, in other words, cases occurring following operation for some suppurative or other lesion within the abdomen. There may be a period following operation during which the patient appears to be making satisfactory progress. Then, the symptoms and signs of sub-phrenic infection appear.

SYMPTOMS

The initial symptoms of sub-phrenic infection are those of toxæmia. In a typical case the patient is recovering or has just recovered from an abdominal infection or has recently been operated upon for such a condition. Then for no apparent reason everything seems to go wrong; the temperature, which may have been normal for a few days, slowly rises, and as the condition progresses it becomes remittent or intermittent; the patient feels and looks ill; he is flushed and suffers from an occasional chill, his tongue is coated and his breath fætid; the pulse-rate gradually rises but is full and bounding.

The first local symptom is pain, which, although it varies considerably in intensity, may be nothing more than a persistent upper abdominal discomfort. It is always worse on deep inspiration and on movement of the body. In infections of the right posterior superior space pain may be felt in the kidney region or beneath the costal

margin. It may be referred to the shoulder or even to the neck muscles. With sub-hepatic infections pain is experienced more internally along the costal margin or perhaps a little below this in the hypochondrium. The pain becomes very severe and is aggravated as the abscess increases in size and involves a wider area of peritoneum or the parietes. Dyspnoea, a tickling cough and hiccough may be troublesome features.

Examination. There may be impairment of the movement of the right half of the abdomen and chest, and the lower ribs may appear to be pushed forward. In infections of the right posterior superior space there may be marked tenderness on deep pressure over the twelfth rib, while in retroperitoneal infections the right flank may be sensitive to the touch.

Supra-hepatic abscesses, and more especially the large ones, may force the liver downward and so increase the area of hepatic dulness. Sometimes the edge of the liver may be palpable below the costal margin.

Infra-hepatic abscesses generally cause guarding and tenderness over the corresponding rectus muscle. In about 10 per cent of cases there may be an accumulation of free gas in the abscess cavity and when this occurs percussion will often demonstrate four fairly distant zones; below, the note is dull over the liver; above this, the note is tympanitic owing to the gas in the abscess; above this again, the note is dull on account of pleural effusion or collapsed lung; while higher up, above this last zone, the normal resonance of the lung is elicited.

Physical examination of the chest may reveal: 1. Elevation and limited movement of the diaphragm. 2. Decreased or absent breath sounds in the lower chest. 3. Physical signs of fluid in the chest above the diaphragm. An accumulation of fluid in the pleural cavity on the affected side is quite a common finding in the early case and is not necessarily of serious significance.

Of all ancillary methods of investigation *X-ray examination* is of the greatest help in diagnosis. The skiagrams should be taken with the patient in the upright position, and antero-posterior and lateral views should also be obtained during full inspiration and on expiration.

The X-ray findings include: 1. Limitation of movement on one

side of the diaphragm. This finding is suggestive of sub-phrenic infection but not necessarily of sub-phrenic abscess. 2. Elevation of the affected half of the diaphragm. This is suggestive of abscess formation. 3. Obliteration of the costo-phrenic angle. 4. Haziness of the lung field. 5. Slight displacement of the heart away from the involved area. 6. Gas bubble with fluid under the diaphragm.

Pancoast (*Am. J. Roentgenol.*, 16:303, 1926) and Granger (*New Orl. M. & S. J.*, 196:518, 1927) have fully stressed the importance of correlating these findings with the clinical data.

A leucocyte count. In over 80 per cent of the cases there is a leucocytosis with a count of over 12,000 white cells per cubic millimetre.

Diagnostic aspiration. Aspiration through the diaphragm as a method of diagnosing sub-phrenic abscess has been advocated and condemned by various surgeons over a period of many years. Doidge and Warner write:

In our opinion it should never be used with one possible exception: that is, in an extremely ill patient where an incorrect diagnosis of sub-phrenic abscess with the resulting unnecessary operation might be fatal. Under these circumstances it may be wise to do a diagnostic aspiration, but it should be done on the operating table and, if pus is found, surgical drainage of the abscess undertaken at once. With this possible exception, diagnostic aspiration should not, in our opinion, be undertaken.¹

In my opinion diagnostic aspiration should never be attempted as it is a highly dangerous procedure. It incurs a definite risk of infection of the uninvolved pleura and peritoneum, and several cases of fatal empyema or of peritonitis have been directly attributable to this form of investigation. In those cases in which the diagnosis remains doubtful, *exploratory operation* should be carried out for preference.

PROGNOSIS

This depends upon:

1. The virulence of the infection and the resistance of the patient. These, of course, are uncontrollable factors.
2. The time which elapses between the development of the infection and the institution of treatment.

¹ Doidge and Warner, *Surg.*, 1:405, 1938. Courtesy of C. V. Mosby Co.

3. The presence of complications and especially of thoracic complications.

4. The type of treatment employed. The earlier the recognition of a sub-phrenic abscess and the earlier the correct type of drainage is instituted, the better the prognosis. Death from sepsis is the price which is paid for delay in treatment.

The importance of operative intervention, *i.e.*, incision and drainage, in sub-phrenic abscess is emphasised by the fact that of 3,038 cases investigated by Ochsner and De Bakey there were 1,096 cases *not* operated upon with 985 (89.8 per cent) of deaths, as contrasted with 1,492 cases operated upon with 637 deaths (32.8 per cent). In Ochsner and Graves' series (1933) the death-rate in those cases with thoracic complications was 52 per cent, whereas in those with no thoracic complications the mortality was only 18 per cent.

The prognosis depends not only upon the institution of drainage, but more particularly upon the type of drainage employed. For instance, transpleural drainage has a mortality of about 40 per cent, trans-peritoneal drainage about 35 per cent, while the death-rate following drainage by the extra-serous approach may be as low as 6 per cent. The employment of that type of drainage which completely avoids the slightest possibility of contamination of the pleural and peritoneal cavities is therefore of the greatest importance. Thus

of 932 collected cases, 394 had transpleural drainage with a mortality of 36.2% and 327 had trans-peritoneal drainage with a mortality of 35.1%, while in the remaining 211 cases with extra-serous drainage there was a mortality of 20.8%. In our combined series the corresponding mortality rates were 50%, 42.8%, and 10.8%.

Whereas in our previously reported 50 cases the operative mortality rate was 32%, in the present group of 25 cases it is 11.7%. This material reduction in mortality is largely due to the greater percentage of employment of extra-serous drainage procedures in the latter group.

In the 15 cases of the present group in which the type of drainage employed was extra-serous, there was only 1 death (6.6%).²

TREATMENT

Conservative treatment should be given a trial unless the clinical manifestations and the radiological investigations indicate or strongly

² Ochsner and De Bakey, *Internat Abstr Surg*, 66:126, 1938.

the surgeon to localise the collection of pus and to plan his approach before embarking upon the operation.

Here are Cokkinis's observations on the trans-serous route:

The *transpleural route* has the doubtful privilege of being "classical." Its advocates attempted to minimise the dangers of pleural contamination by ingenious devices, but unfortunately without appreciable difference to the mortality. Thus, Trendelenburg, in 1893, suggested that the part of the pleural cavity which has to be traversed in the transpleural approach may be isolated, after the resection of one or more ribs, by a circle of sutures stitching the costal and diaphragmatic layers of the pleura together; this procedure has been copied from text-book to text-book for nearly fifty years, but experience has proved it to be worthless. A few years later, 1899, Boeckel pleaded that a low trans-thoracic approach could miss the phrenico-costal sulcus of pleura, as this is pulled up out of the way by the elevation of the diaphragm; this comforting suggestion has been used as an excuse for the trans-thoracic approach by numerous surgeons, but recent work proves that it has no foundation in fact. Realising the dangers of the transpleural route, its advocates finally brought forward a two-stage procedure, the first stage ending with the resection of two or more ribs; unless the pleura over the abscess has already been obliterated by adhesions, these are encouraged to form by packing iodoform gauze against the pleura. A week or so later the pleural cavity in the floor of the wound will be obliterated, and an incision can be made through it and the diaphragm into the abscess (second stage). We cannot speak of this procedure from experience but apart from other considerations, the delay of a week condemns it.

The *transperitoneal route* (for anterior sub-phrenic abscesses) is subject to the risk of infecting the peritoneal cavity. Carefully packing off the approach to the abscess, and complete evacuation of the pus with a sucker, diminish this danger, but do not remove it entirely. Neither is the danger of peritonitis completely obviated by a two-stage transperitoneal operation.

It is our firm conviction that the transpleural and transperitoneal routes should be abandoned as surgically unsound and dangerous, especially in early cases. In neglected cases the danger is not so great, since there is a good prospect of the pleura or peritoneum over the abscess being obliterated by adhesions. But as we can never be certain of this, and we must above all provide for early intervention, only the safer *extra-serous* operations will be described. (Cokkinis.)

There are two methods of extra-serous approach: 1. The posterior approach, through which the right posterior superior, the right inferior, the left posterior inferior, and the retroperitoneal spaces can be reached; and

2. The anterior approach, through which the right anterior superior, the left superior and the left anterior inferior spaces can be reached.

The Posterior Extraperitoneal Operation. On the right side this is the best approach for abscesses in the right posterior superior space, the retroperitoneal space and the right inferior space which, between them, constitute the site of about 70 per cent of sub-phrenic abscesses. On the left side it is the ideal approach for the rare abscess in the left posterior inferior space or lesser sac. The operation is conducted as follows: Assuming that the operation is to be performed on the right side, the patient is placed on the left side, as in operations for exposure of the right kidney. An incision is made along and down to the right twelfth rib, and when this is exposed it is resected subperiosteally. After retracting the bulky erector spinae muscle, a transverse incision is made across (not parallel to) the bed of the resected rib, dividing the spinal attachment of the diaphragm at the level of the first lumbar spine (fig. 212 [1]). By making the incision horizontal and by keeping it at the level of the first lumbar spine, injury to the pleura can be avoided with certainty, as Melnikoff (*Arch. f. klin. Chir.*, 123:133, 1923) has demonstrated in his extensive anatomical investigations.

After dividing the diaphragm, the renal fascia is encountered. This is displaced downward with the kidney until the lower edge of the liver with the sub-hepatic space of peritoneum is seen and felt. The right inferior space is carefully palpated for a possible abscess, and any doubt is dispelled by aspiration. If an abscess is found here, it should be opened with the finger and drained. A retroperitoneal collection of pus will also show itself at this stage or in the early part of the next stage of the operation.

This stage consists in peeling off the peritoneum from the under-surface of the diaphragm with the object of reaching an abscess in the right posterior superior space. This separation is best effected with the finger and is rendered easier by the oedematous condition of the peritoneum when an abscess is present in this vicinity.

The separation is continued until an indurated mass is felt, which is the abscess. Any doubt is settled by aspirating the mass, after which the abscess is opened by pushing the finger gently through its wall and the pus is withdrawn with a suction tube. Two or three

large soft fenestrated rubber tubes are inserted into the abscess cavity and anchored to the skin, and the wound is then sutured.

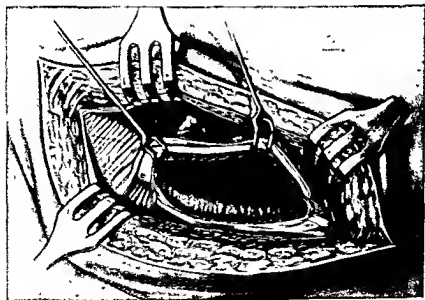
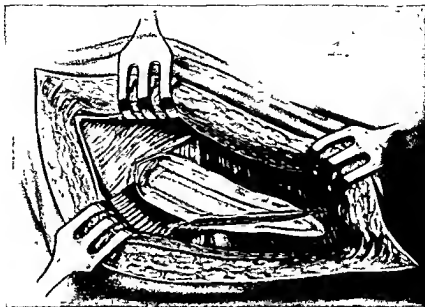


FIG. 212.—SUB-PHRENIC ABSCESS: POSTERIOR EXTRA-PERITONEAL OPERATION.
(After Ochsner.)

The Anterior Extraperitoneal Operation. On the right side this is the best approach for abscesses in the right anterior superior space. It may also be employed for a right inferior abscess when we are

certain that the right posterior superior space is not involved. But this is less suitable for drainage than the posterior approach.

On the left side it is by far the best approach for abscesses in the left superior and left anterior inferior spaces.

An incision is made one finger's breadth below and parallel to the costal margin on the affected side, as suggested by Clairmont and Meyer (*Acta. chir. Scandin.*, 60:55, 1926). All the structures are divided in line with the incision itself, but not including the parietal peritoneum. The peritoneum is next peeled off the diaphragm until the abscess can be felt. After aspirating the abscess it is opened by forcing the finger through its wall. The pus is evacuated, and soft drainage tubes or rubber sheeting are inserted into the cavity. The wound is lightly closed.

If during the performance of an extraperitoneal operation it is found that the abscess is already firmly adherent to the parietal peritoneum and that the peritoneal cavity is completely obliterated in this region, the abscess can be opened directly by pushing the finger through the adherent wall.

CHAPTER 4

MESENTERY AND OMENTUM

TUBERCULOUS MESENTERIC LYMPHADENITIS

The lymphatic glands of the abdomen are classified into two large groups, visceral and parietal, each of which is subdivided into smaller groups according to the organs or regions they drain.

Thus:

Visceral	{ gastric pyloric splenic hepatic pancreatic mesenteric ileo-cæcal colic cæliac	Parietal	{ iliac lumbar sacral aortic anterior abdominal
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In tuberculous mesenteric lymphadenitis the lymph glands of the mesentery and retroperitoneum become enlarged and often caseate; occasionally they suppurate or calcify, calcification being more frequent. The condition is most often seen in early childhood, when it must be assumed that it originates from the consumption of milk obtained from tuberculous cattle. The incidence varies very considerably in different parts of the world.

The disease may be a primary lesion or may be secondary to tuberculosis of the intestine or lungs. In the *primary* cases, the glands become infected without any evidence of disease being found in the intestine. It must therefore be inferred that the bacilli have passed directly through the intact intestinal wall, or that a small lesion has formed which has healed so completely that no evidence of it remains. In the *secondary* cases, there are gross tuberculous foci in the lungs or intestines which account for the lesions in the abdominal glands. The commonest sites of infected lymph nodes are the ileo-

cæcal angle, the retroperitoneal spaces medial to the cæcum and ascending colon, and the lower part of the mesentery of the small intestine. Occasionally a single chain of glands will be seen following the course of the ileocolic artery to the root of the mesentery (fig. 213).

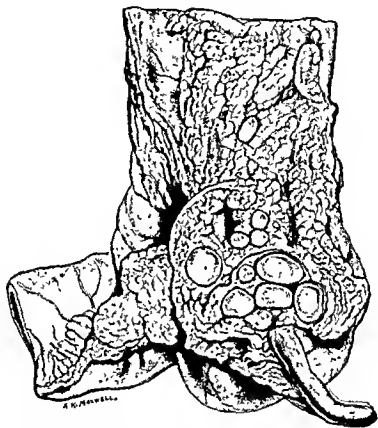


FIG. 213.—TUBERCULOUS GLANDS OF THE ILEO CÆCAL REGION (POSTERIOR ASPECT), MUSEUM, ROYAL INFIRMARY GLASGOW.

DIAGNOSIS

On X-ray examination, visceral mesenteric glands, when calcified, have a conglomerate appearance like the aggregation of many small particles, the ileocecal group being the one most commonly affected. These calcified glands are found in the right iliac fossa; they can be palpated in thin patients, and are sometimes tender, generally mobile, and may in pregnancy be displaced high up in the upper abdomen. In visceroptosis they may be seen in the pelvis. Apart from

mesenteric glands, calcification of other visceral groups is less common, isolated calcified glands being found in the coeliac, colic and hepatic groups in a few cases, but very rarely in the gastric groups. Calcification in parietal glands is more discrete, causing single, clear-cut shadows which in the lateral view are seen to be deep in the abdomen. Such shadows may be difficult to differentiate from renal calculi. Of the parietal glands the anterior abdominal group is very rarely calcified. The most difficult differential diagnosis is between a calcified lumbar gland adjacent to a kidney pelvis and a renal calculus. These two conditions cannot be differentiated by antero-posterior and lateral films as in the other groups, and it is necessary both to examine the renal pelvis with a pyelogram and to take the clinical evidence into account. In the same way gall-stones are distinguished by a cholecystogram. Calcified fibroids and lithopædion are larger than glands. Calcification around a foreign body assumes the shape of that body. The teeth in dermoid cysts are usually recognisable as such. (Horny warts on the skin may throw shadows like those of calcified glands.)

Reeves (*Am. J. Roentgenol.*, 22:305, 1929) found that in 23 of 29 unselected cases the glands were situated in the right lower quadrant of the abdomen. This localisation is attributed by them to the normal slowing up of the intestinal contents in the intestinal tract. All stages of the tuberculous process may be found in these mesenteric lymphatic glands—tubercle formation, caseation, and calcification. The older the patient the more likely the glands are to contain calcium; in young patients it is the exception, although occasionally a large, thick-walled, cystic tumour may be found which resembles a dermoid and contains yellow creamy material, together with depositions of chalk.

The disease is very protean in its clinical manifestations, but frequently three varieties may be recognised.

CLINICAL TYPES

In the *acute* type, which is so commonly seen in children, the symptoms mimic those of acute appendicitis, acute gastro-enteritis, acute pyogenic abdominal lymphadenitis, or "gastric influenza." The patient feels languid and ill, and complains of intermittent bouts of

abdominal pain especially referred to the umbilicus or right iliac fossa. The pain may be dull and dragging in nature, or sharp and colicky. Sometimes there are severe attacks accompanied by nausea and vomiting, and the pain may radiate to the back or down the thighs. After a day or two the pains tend to subside, only to recur later with added acuteness. The patient suffers from lack of energy of mind and body; fever is usually continuous (99° to 104° F.), although it may be intermittent sometimes; and there may be constipation, although diarrhoea is the rule, the stools being thin, watery, dark and extremely offensive. Diarrhoea is more likely to be present if there is any associated ulceration of the intestine. The face is pale, with flushed spots on each cheek, the lips are dry, the tongue is coated, and the abdomen distended, tumid, and tender on palpation. This tenderness is most noticeable in the right iliac fossa or in the hypogastrium, and on deep palpation one or two painful areas or palpable masses may be made out.

These patients are usually submitted to operation after a variable period of watchfulness and the performance of serological tests, a diagnosis of questionable retrocaecal or pelvic appendicitis usually being made. At operation the appendix will be sought for, and although it will often be found to be normal in appearance it should, nevertheless, be removed in all cases. A little clear free peritoneal fluid will be present, and this must be quickly mopped up or evacuated by means of a suction tube. The glands in the mesentery and retroperitoneum are extremely plentiful, slightly enlarged, and rubbery in consistency; there is little or no peri-adenitis, but one or two nodes here and there may feel hard and gritty. After removing a gland for biopsy, the abdomen should be closed without drainage. The post-operative results are on the whole eminently satisfactory, although it is difficult to understand why this should be so. In some cases convalescence will be stormy, and recovery to health slow, while in a few cases death will follow from a rapid spread of the tuberculous process or from generalised tuberculosis.

In the *chronic* type of the disease, the involvement of the glands gravely interferes with nutrition, and the patient is wasted and anæmic, and tires easily on exertion. The symptoms are intensified by the frequent association of local tuberculous peritonitis. The abdomen is distended and tympanitic, but owing to the distension no

enlarged glands can, as a rule, be felt. In some cases, however, nodules or a freely movable tumour mass can be made out to the right of the umbilicus. Diarrhoea is a constant feature, and the fat-laden stools are bulky, whitish, frothy from fermentation, and malodorous. There is a moderate pyrexia, but the general wasting and weakness are the most characteristic features. Anorexia, gastric upset, chronic abdominal pain, the discomforts associated with a gradually increasing distension of the abdomen, lassitude and drowsiness are the usual symptoms of which the sufferer from tuberculous mesenteric lymphadenitis complains.

TREATMENT

The treatment of this condition is primarily medical, but during the course of the disease the following complications may occur and call for surgical measures: (1) intestinal obstruction, which may be acute or chronic and which is due to adhesions which form between the breaking-down nodes and a neighbouring portion of the gut; (2) pressure effects upon neighbouring structures, *e.g.*, at the root of the mesentery, compressing the third part of the duodenum and so producing duodenal ileus, or pressure or dragging upon the ureter causing ureteric colic or hæmaturia, and (3) perforation of a breaking-down lymphatic gland, simulating a ruptured appendix and causing a localised abscess or diffuse peritonitis.

In the *third* type, the disease is spent, and only the chalky tombstones of the dead bacilli remain as witness of the struggle that has once taken place. But although calcified abdominal glands are often clinically silent and innocuous, they may at times be the cause of recurrent, crippling abdominal pains, severe colic, intermittent hæmaturia, or even intestinal obstruction.

Calcified abdominal glands are encountered in 65 per cent of subjects in the course of routine X-ray examinations. They are not commonly observed before the age of 12, and the sexes are affected with equal frequency. It is interesting to reflect that in the great majority of patients who have them, the glands affected are those of the ileo-cæcal group. This is a small group—four or five glands at the most—and yet it is the group picked out for tuberculous infection in about half the population.

Thomson-Walker (*Genito-Urinary Surgery*, 2nd ed., 1936) found that in 11 out of 42 cases the symptoms were sufficiently severe to justify the removal of the calcified glands by operation. The result in all these cases was the disappearance of the pain, whether it had been in the nature of recurrent attacks of colic or of continuous dull aching. It is generally agreed that, since these glands represent the terminal stage of the disease and since, given careful surgical technique, there no longer exists a danger of dissemination of the tubercle bacilli, the question as to whether to operate or not should depend upon the severity of the symptoms. Operation is only justifiable when the pain is recurrent and severe and is considered to be directly due to the presence of the glands. In those cases when hæmaturia is due to dragging on the ureter by a mass of glands, the abdomen should be opened and the culpable glands removed.

TUMOURS OF THE MESENTERY AND OMENTUM

Primary innocent and malignant tumours of the peritoneal endothelium probably do not exist. A few cases of primary tumours of the blood and lymph vessels of the mesentery and of the omentum and of the connective tissues of these two structures have been recorded, but they are of little surgical interest (Herrman and Soloff; *Am. J. Surg.*, 30:125, 1935). These primary growths are slow-growing sarcomata and do not give rise to any symptoms, such as intestinal obstruction, until they attain a very large size. They are for the most part discovered accidentally during the course of abdominal examination. When discovered at laparotomy they should be freely excised together with a wedge-shaped portion of the mesentery and adjacent coil of intestine (Guernsey, *Proc. Staff Meet. Mayo Clinic*, 14:44, 1939).

Secondary tumours are, of course, very common, and in the majority of cases they are metastatic deposits from primary carcinomata within the abdomen, most often from the stomach, colon, ovary or biliary system. In some cases they are derived from carcinomata situated outside the abdomen, *e.g.*, cancer of the breast.

The principal features associated with these secondary carcinomata of the peritoneum are ascites and multiple nodular tumours which may at times be felt through the abdominal wall or in the pelvic floor on rectal or vaginal examination.

Cysts of the omentum, mesentery and retroperitoneum may be classified as follows:

1. *Cavernous Lymphangiomata*. These lymphatic cysts are chiefly encountered in childhood. When occurring between the leaves of the mesentery they are usually single, but when forming in the great omentum they are often multiple and resemble a bunch of grapes. The walls of the cyst are composed of fibrous tissue and they are generally lined with cubical endothelium. They usually contain clear or milky fluid. When encountered in the great omentum, this structure should be resected. When forming in the mesentery, and particularly when they are of great dimensions, marsupialisation is a safer procedure than excision. Enucleation of the cyst is not always a practicable procedure and when carried out is associated with a mortality of 9 per cent (Jackman and Mayston, *Brit. M. J.*, 2:1079, 1936).

2. *Gas Cysts*. According to Boyd (*Surgical Pathology*, 4th ed., 1938), these are usually quite small and are found clustered along a segment of the bowel.

3. *Dermoid Cysts*. These are frequently retroperitoneal in position.

4. *Hydatid Cysts*. These are not uncommonly found in the omentum and mesentery.

5. *Wolffian Cysts*. These arise from any part of the early urogenital system.

For more detailed information concerning cysts of the omentum, mesentery and retroperitoneum the reader is referred to the excellent contributions by Berger and Rothenberg (*Surg.*, 5:522, 1939); Handfield-Jones (*Brit. J. Surg.*, 12:119, 1924); Stoney (*Brit. J. Surg.*, 12:789, 1924); Warfield (*Ann. Surg.*, 96:789, 1932); Hafezi (*Brit. J. Surg.*, 26:26, 1937); Jewesbury (*Lancet*, 1:1170, 1937); Muir (*Lancet*, 1:742, 1935); and Moynihan (*Ann. Surg.*, 26:119, 1897).

TORSION OF THE OMENTUM

The great omentum sometimes becomes twisted on its axis, and as a result of congestion and inflammation a painful mass develops within the abdomen. Torsion is particularly likely to take place when a large mass of omentum is imprisoned in a hernial sac. The twisting

may occur in a part occupying a hernial sac or it may occur in omentum lying wholly inside the abdomen.

In most cases the involved portion of omentum soon becomes œdematous, engorged with blood and finally gangrenous. Peritonitis may result through infection from gangrenous omentum. The condition is seldom correctly diagnosed until the abdomen has been opened.

The *treatment* is ligature of the pedicle an inch or so above the twist, and excision of the mass.

PART IX

EXTERNAL ABDOMINAL HERNIA

CHAPTER I

INGUINAL HERNIA

This part deals principally with the *operative* treatment of the commoner varieties of external abdominal hernia. Strangulated external hernia, which is the commonest cause of intestinal obstruction and therefore of outstanding interest to the surgeon, is also discussed. Those who seek more detailed instruction in this subject and also in the rarer varieties of hernia are referred to Watson's authoritative monograph, *Hernia* (2nd ed., 1938) and also to the well-known contributions of Hamilton Russell, Keith, Philip Turner, Sampson Handley, Gallie, Wyllys Andrews, Halsted, Bloodgood, Schmieden, Downes, Lenthal Cheatele, A. K. Henry, Ogilvie, Keynes and Coley.

No account is here given of the injection treatment of reducible inguinal hernia. I gave this method a trial but was quick to mend my ways. This form of treatment has, however, been warmly advocated by Ignatz Mayer (*Med. J. & Rec.*, 125:528, 1927), by Delisle Gray (*Brit. M. J.*, 2:12, 1932) and others.

According to Erdman (*Ann. Surg.*, 77:171, 1923), inguinal hernia constitutes 82 per cent of all external abdominal herniæ; incisional or post-operative hernia 8 per cent; femoral hernia 4.5 per cent; umbilical hernia 3.8 per cent; epigastric hernia 0.7 per cent; and the other rarer varieties about 1 per cent.

Inguinal and femoral hernia are divided between the sexes as follows: female inguinal 9 per cent, male inguinal 81 per cent; female femoral 7 per cent, male femoral 3 per cent.

There are two main types of inguinal hernia: the *oblique* or *indirect* and the *direct*.

In the former, the hernial orifice is lateral to the deep epigastric artery, while in the latter it is medial to it. The oblique hernia accompanies the cord. It lies in the same fascial sheath and by it is led along the inguinal canal parallel to Poupart's (inguinal) ligament,

through the external abdominal ring, into the scrotum and finally to the testicle.

In the latter type, the hernia goes through the abdominal wall, behind and not in any particular relationship to the cord, which is merely a structure anterior to it and may lie above it, below it or over its summit.

It therefore has the intercolumnar and cremasteric coverings of an oblique hernia, but not the internal spermatic layer, while in addition the transversalis fascia of the posterior inguinal wall covers it. As it enlarges, its spread is limited by the attachments of this fascia to Poupart's ligament and the ilio-pectineal line. Being a bulging of all the layers of the abdominal wall, it will continue to bulge them in a centrifugal manner, being only limited by the relative strength of the structures it encounters. Poupart's ligament, and the outer border of the rectus near its insertion, here reinforced by the pyramidalis, are almost unyielding, so that the hernia will push upward and outward, finally stretching the muscles far beyond the confines of the inguinal canal, but never, or hardly ever, entering the scrotum.¹

LOCAL ANÆSTHESIA

In most cases the choice of anæsthetic is immaterial, but if the patient is aged or his general condition is poor, if he is suffering from a severe cough or some intercurrent disease such as diabetes or nephritis, or if strangulation is present, local anæsthesia is the method of choice.

The solution used is 1 per cent novocaine (without adrenalin), and between 100 and 150 cc. is required for the injection in order to obtain satisfactory anæsthesia. Three superficial wheals are raised, the first about 1 to 1½ inches medial to the anterior superior spine, the second over the saphenous opening, and the third just above and medial to the external abdominal ring. A 3 or 3½ inch needle is used for the injections. The needle is first introduced through the first wheal and pierces the skin in a backward and slightly outward direction until it is felt to pierce the muscles and impinge against the bone. About 20 cc. is injected in this region to block the ilio-inguinal, the ilio-hypogastric and the last dorsal nerves. The injection should be given slightly fanwise and the muscles be freely infiltrated. Using the same wheal, the needle is next passed deep to the external oblique

¹ Ogilvie, *Proc. Roy. Soc. Med.*, 30 681, 1937.

muscle and aponeurosis, and 10 cc. is injected along a line between the first and third wheals in such a way that the upper aspect of the cord and the under surface of the aponeurosis are freely bathed in the solution. Another 10 cc. is then injected along the inner and upper side of Poupart's ligament for its whole length. The base of the scrotum is now held up, and through the second wheal (over the saphenous opening) 20 cc. of the solution is run into the root of the scrotum to block the scrotal nerves, and 5 to 10 cc. is injected in the region of the pubic spine behind the cord, which is elevated for this purpose.

Through the third wheal the needle is introduced behind the cord, which is again lifted up. About 10 to 15 cc. is run into this area to block the spermatic nerve and genital branch of the genito-crural nerve.

Finally, through all three wheals a complete circum-injection of the subcutaneous tissues is performed, using in all between 30 and 40 cc. of the novocaine solution. After this injection has been completed, the surgeon should wait fully ten minutes before commencing the operation. The anæsthesia will last in the average case from 1 to 1½ hours.

In operations for femoral hernia, the same method of anæsthesia is employed, but the surroundings of the sac, and more particularly the neck of the sac, must be infiltrated very freely in order to obtain complete loss of sensation.

OPERATIONS FOR THE RADICAL CURE OF INGUINAL HERNIA

There are a large number of operations practised for the cure of inguinal hernia, as reference to Watson's monograph will readily show; but I shall here describe only those operations which I myself recommend and practise.

1. **The Standard Operation.** This is indicated for those cases of oblique inguinal hernia (congenital or acquired) in which the margins of the internal abdominal ring have not become stretched or displaced, where the muscle defences are good, and the fibrous framework is intact; in fact, for cases in which the only abnormality discoverable is the presence of a hernial sac. Here, removal of the entire

sac without inflicting any damage upon the muscular or fibrous tissues of the inguinal region and accurate apposition of the divided structures are all that are necessary to obtain a permanent cure. Plastic operations for this type of case are unnecessary, harmful and even mutilating.

2. Partial Reconstruction of the Posterior Wall. This type of operation is sometimes indicated in oblique inguinal hernia where the muscles are in good condition, but where the margins of the internal abdominal ring have become slightly stretched. Here, after removal of the entire hernial sac a small plastic operation is carried out with the object of fortifying the posterior wall and restoring the diameter of the internal ring to equal that of the cord. The internal oblique muscle and the aponeurosis are not used in this repair.

3. Operations for Large Oblique Inguinal Herniæ in which the Margins of the Internal Abdominal Ring and the Posterior Wall of the Inguinal Canal are unduly Stretched and the Inguinal Muscles Themselves may or may not be Slightly Atrophied. Here the surgeon has a choice of many operations including those of (a) Bassini; (b) Wyllis Andrews; (c) Halsted, and (d) Bloodgood.

4. Operations for Direct Inguinal Hernia where the Fibrous Tissues are badly Stretched and the Muscles Atrophied. Here, as Ogilvie (1937) points out, there is no likelihood of the weakened muscles regaining their sphincteric action and a new mechanism, foreign to the body but perfectly satisfactory if well planned and carefully executed, must be devised. Such operations usually involve the construction of new internal and external abdominal rings, which must be rigid and placed far apart, and the making of a strong fibrous posterior wall to the canal. The muscles are necessarily used in such operations, but they cannot without further reinforcement provide a sufficiently strong sheet to prevent recurrence. The most dependable procedures for direct inguinal hernia are:

- (a) Gallie's operation; and
- (b) The floss-silk lattice repair method.

THE STANDARD OPERATION

The usual incision is a straight one placed parallel to Poupart's ligament and about $\frac{1}{2}$ inch above it, and extending from 1 inch

lateral to the internal ring to a point overlying the centre of the external ring. This incision gives direct access to the structures of the inguinal canal, but often leaves an ugly stretched scar, which may at times be keloid. A more transverse incision, one placed in the natural crease in this region, is to be preferred. It commences 1 inch or so below and to the outer side of Poupart's ligament, and extends inward, crossing this ligament at the junction of the middle and outer third, to within 1 inch of the midline, $1\frac{1}{2}$ inches above the symphysis pubis (fig. 214 [a]). The incision is deepened and the superficial femoral blood vessels are identified, clipped, divided and ligatured with fine plain catgut, after which the subcutaneous tissues are separated down to the shiny aponeurosis. The upper skin flap is picked up with a pair of toothed dissecting forceps and dissected upward to expose a wide area of the aponeurosis, and in an outward direction for $1\frac{1}{2}$ to 2 inches beyond the internal ring. The lower flap is cautiously freed in order to display Poupart's ligament and the attachment of this ligament to the pubic spine (fig. 214 [1]). The external ring should be carefully displayed, after which an incision $\frac{1}{2}$ to 1 inch long is made in the aponeurosis in the line of the pillars and about 1 inch or so from the point where they diverge. This incision is lengthened laterally for 1 to $1\frac{1}{2}$ inches, and medially it cuts across the stretched fibres of the aponeurosis and the lacing bands of inter-columnar fascia.

The upper leaf of the aponeurosis is clipped with artery forceps and retracted upward and inward in order to free it from the underlying cremaster and the arching fibres of the internal oblique muscle, and to display the outer border of the rectus sheath. The lower leaf is then likewise clipped and retracted downward and outward, but it is most important not to disturb that portion of the cremaster muscle which arises from Poupart's ligament (fig. 214 [2]). In the upper part of the wound, which is now displayed, the ilio-hypogastric nerve will be seen coursing downward to disappear in the region of the pubis, and a little below this, lying on the surface of the cremaster, is the ilio-inguinal nerve which must on no account be damaged during the subsequent dissection (fig. 214 [2]).

The cremaster muscle is next picked up about $\frac{1}{4}$ to $\frac{1}{2}$ inch below the ilio-inguinal nerve, and cautiously divided with scissors in order to open up and expose the sub-cremasteric areolar space. The upper

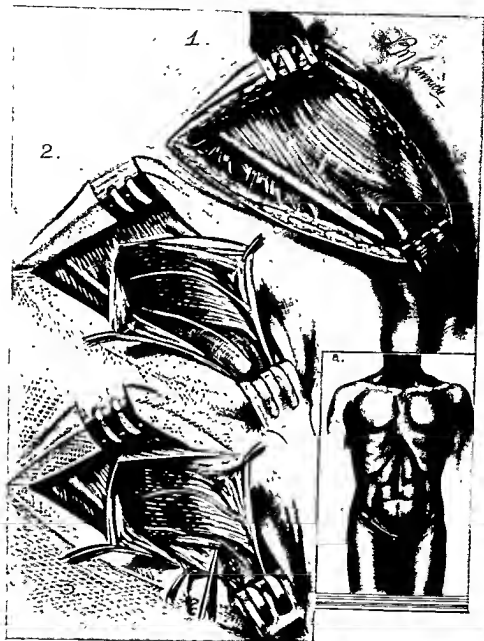


FIG. 214.—THE STANDARD OPERATION FOR REDUCIBLE OBLIQUE INGUINAL HERNIA.

edge of the cut cremaster muscle is carefully freed from the components of the cord, and after this has been done its lower edge is gently dissected from the cord in order to expose it more fully (fig. 214 [3]).

The cord is picked up and the left index finger is passed underneath it. The cord is covered with infundibuliform fascia only, and after this has been incised the hernial sac can be clipped with a hæmostat and drawn outward to assist in its separation from the vas and the blood vessels (fig. 215 [4]). In oblique inguinal hernia the sac will be seen lying anterior to the vas and blood vessels. The structures adhering to the sac are then separated with non-toothed dissecting forceps by working transversely to its long axis. As soon as this separation has been effected, the vas and blood vessels are clipped in one bundle by enclosing them in the loop of a pair of Morant Baker forceps.

After freeing the fundus, the dissection proceeds toward the internal ring in order to isolate the neck of the sac. So as to obtain a clear view of the neck, a small retractor is inserted under the upper leaf of the cremaster muscle and draws this muscle and the lower fibres of the internal oblique upward and outward. The neck of the sac is dissected until a cuff of extraperitoneal fat is exposed. The fundus is then grasped with artery forceps, opened, and a probe passed through the neck into the peritoneal cavity to make quite sure that no contents are adherent at the neck (fig. 215 [5]). The sac is next twisted until the turns reach the internal ring. The neck of the sac is transfixed and ligatured, after which the sac is cut away about $\frac{1}{2}$ inch distal to the ligature. The stump quickly disappears behind the aperture in the transversalis fascia and passes out of view (fig. 215 [6]).

The internal ring is now examined to see whether it is stretched or weakened. If it is found to be adequately strong, the cord is replaced in its bed and the edges of the cremaster muscle are approximated either with a continuous suture of No. 00 twenty-day chromic catgut or with interrupted sutures of the same material. The margins of the external oblique aponeurosis are then drawn together with interrupted sutures of No. 00 chromic catgut (fig. 215 [7]). When the external ring is reached, the pillars are reconstructed to their normal size and the ring is reduced to a size that will transmit the cord comfortably, *i.e.*, to about the size of the little finger. The subcutaneous layers are then approximated with a series of interrupted sutures of fine plain catgut, after which the skin margins are united with a few interrupted vertical mattress sutures and Michel clips (fig. 215 [8]).

The operation is completed by applying a small gauze dressing over the wound and keeping this in place with adhesive plaster.

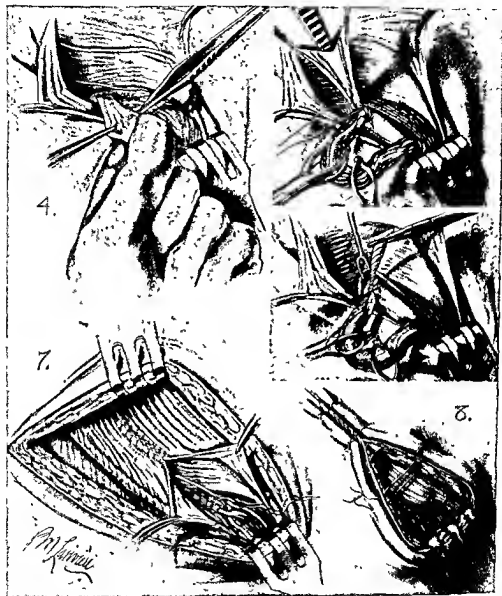


FIG. 215—THE STANDARD OPERATION FOR REDUCIBLE OBLIQUE INGUINAL HERNIA.

The clips are removed on the second or third day, and the vertical mattress sutures on the fourth or fifth post-operative day. The patient is kept in bed for three weeks.

INGUINAL HERNIA IN THE FEMALE

Inguinal hernia in the female is commonly due to the persistence of a congenital sac which is often firmly adherent to the round ligament. The round ligament is narrower and less vascular than the cord. The inguinal canal, too, is smaller in the female and the cremaster is an insignificant structure.

The operation for the radical cure of inguinal hernia in the female is similar to the standard operation in the male up to the stage when the cremaster is reflected from the round ligament. The hernial sac, which is exposed, the round ligament and the accompanying vessels are then picked up together and freed from the inguinal canal and from the labium by blunt dissection. The round ligament close to its insertion is clamped, ligatured and divided, after which this structure with the adherent sac is cleared as far as the internal abdominal ring. The sac is opened, its interior is inspected, a probe is inserted into the peritoneal cavity to make sure that no structure is adherent to the sac, after which the neck of the sac together with the round ligament and its accompanying vessels is crushed with artery forceps, transfixed, ligatured and then cut across $\frac{1}{2}$ inch beyond the ligature.

The narrow inguinal canal is now empty, and it is an easy matter to obliterate it with a few interrupted sutures of No. 00 chromic catgut by anchoring the conjoined muscle to Poupart's ligament. When this is accomplished, the edges of the external oblique aponeurosis are drawn together with a continuous suture and the skin edges are closed in the manner already described. The round ligament may be preserved in those cases in which the sac can be readily separated from the round ligament.

Some surgeons, after transfixing and ligaturing the sac and the bundle of the round ligament, leave the ends of the ligature long so that after the excess of sac and round ligament have been cut away, the stump can be securely anchored to the aponeurosis of the external oblique muscle, immediately above the internal ring. In this way the suspensory functions of the round ligament are not materially interfered with.

INGUINAL HERNIA IN INFANTS

Inguinal hernia is more common in boys than in girls. Thus in Paterson and Gray's series of 773 cases there were 696 males (90 per cent) and only 77 females (10 per cent), and of these 62 per cent were on the right, 20 per cent were on the left, and 18 per cent were double. Barrington-Ward states that if a hernia is found on the left side in an infant it is usual to find a sac on the right side also, even though no hernia has been demonstrated at that site. There are many surgeons who make a practice of searching for a hernial sac on the right side when operating for a left inguinal hernia. Omentum is rarely found in the hernial sac. It is the small intestine which most commonly occupies the sac, and on the right side the cæcum and appendix not infrequently find their way into a hernial sac. In the female the sac may contain the ovary.

The treatment of inguinal hernia in infants by means of a truss is in most instances most unsatisfactory, unclean and tiresome, and is a source of irritation to the child and to the skin of the inguinal region. Nevertheless, a truss should be ordered:

(a) For infants under six months of age; and

(b) For children whose general condition precludes any operation, unless the hernia is unduly large, rapidly increasing in size, or irreducible. In such cases operation should not be unduly delayed, while in the case of strangulation it becomes urgent. This complication is not by any means infrequent in infants between the ages of three and eight weeks. In these cases the hernia descends suddenly and for the first time, and the contents become acutely strangulated.

The only satisfactory treatment for inguinal hernia in children is by operation. This is a simple affair, and when correctly performed yields uniformly satisfactory results; in fact, there should be no recurrence nor should there be any mortality.

Recurrence is due to: (a) not defining the diaphanous sac—the sac is missed; (b) the slipping or the rapid absorption of the catgut ligature which has been applied to the neck of the sac; (c) the incomplete removal of the sac, in other words the sac has not been removed flush with the internal ring; (d) interference with the shutter-like action of the inguinal muscles, *e.g.*, by the performance of the Bassini type of operation.

OPERATIVE PROCEDURE

A small sandbag is placed underneath the buttocks to throw the inguinal region forward. A transverse incision $1\frac{1}{2}$ to 2 inches long is made in the skin crease which is seen to cut across Poupart's ligament. The incision therefore starts below and to the medial side of the anterior superior spine and about $\frac{1}{2}$ to $\frac{3}{4}$ inch below Poupart's ligament, and is carried inward to end just above the fatty pad which covers the external ring. It is therefore placed where it is not likely to be contaminated with urine, and leaves a good scar as it is made in one of the natural creases of the body.

The subcutaneous tissues are divided and the small superficial femoral vessels are picked up and tied with fine catgut. The external oblique aponeurosis and external ring are exposed, after which the operation proceeds as in the standard operation for oblique inguinal hernia in the adult.

It is on occasion extremely difficult to strip off the vas and vessels from the transparent sac, which may be torn into shreds during the dissection. In such cases the neck of the sac itself should be cautiously isolated, tied off and divided, leaving the posterior wall of the sac still clinging to the cord.

The operation is completed by stitching the edges of the aponeurosis together, by narrowing the external ring to the diameter of the cord, by closing the wound with a sub-cuticular stitch of the finest plain catgut, and by applying a strip of waterproof adhesive plaster over the incision so that it cannot in any way become contaminated during convalescence. This strip of plaster is not removed for fourteen days, by which time the wound will be found to be firmly healed.

Some surgeons consider it unnecessary to split up the aponeurosis of the external oblique in order to expose the sac and to ensure that the neck of the sac is ligatured at the correct site. They prefer to expose the sac, retract the widened external ring firmly upward and outward, and after ligaturing the neck of the sac at the internal ring to strengthen the pillars of the external ring with a few interrupted sutures. In actual practice this method works quite well.

In the total funicular type of hernia, where the sac descends to and surrounds the testicle, the operation is simplified by cutting the sac

across just above the testicle and by leaving the "tunica vaginalis" open. The remainder of the sac is then freed to the internal ring and dealt with in the usual manner.

PARTIAL RECONSTRUCTION OF THE POSTERIOR WALL OF THE INGUINAL CANAL

Ogilvie who has done so much to crystallise our views on the operative treatment of the various varieties of inguinal hernia, writes on this very important subject as follows:

The standard operation... is that which offers the best chance of permanent cure in an oblique hernia where the muscular defences are intact, the fibrous posterior wall of the canal sound, and the internal ring unstretched. Many cases are met with, however, in which the internal ring has become damaged while the remainder of the mechanism of the canal remains comparatively sound. The neck of a congenital oblique hernia lies above and to the outer side of the cord, and in its early days represents a potential space only, which does not dilate the fibrous collar of the internal ring. With the repeated entry of abdominal contents into the sac, and particularly with their lodgment there, the ring becomes stretched to accommodate cord plus sac. To start with, the stretching is in that part of the circumference occupied by the sac, that is, the upper and outer segment, and the inner border of the ring is not displaced. With time, however, the whole ring becomes dilated, the inner border, and with it the deep epigastric artery, is displaced medially, and the cord, though still bearing the same relation to the neck of the sac and the artery, leaves the posterior wall much nearer the mid-line than is normally the case.

These observations have an important bearing upon the steps necessary for the repair of the internal ring. Estimation of the size, degree of shift, and strength of the borders of the ring is more easily made by touch than by sight. The size of an unstretched ring is the diameter of the cord when engorged with blood, roughly that of the last joint of the little finger. Such a ring requires no repair. If the surgeon finds that the site where the sac has been tied and cut off appears as a weak area lying outside the cord, but that the cord is not displaced medially, that the inner margin of the ring is firm, and that the deep epigastric artery runs a straight course, he will be content with some simple approximation of the edges of the defect in the transversalis fascia over the stump of the sac. If, on the other hand, he finds that the ring as a whole is dilated, the cord displaced and the artery shifted, he can only restore normal relations by moving the cord outwards to that part of the ring formerly occupied by the neck of the sac, and repairing the weak area to its medial side.

(1) *Simple Suture of the Defect in the Internal Ring.* The weak area must be exposed by drawing the cremaster and internal oblique muscles strongly

upwards with a small retractor, thus bringing into view the transversalis fascia lateral to the cord, the stump of the divided sac, and the defect around it. The margins of the defect are defined by palpation and brought together by a stitch of No. 1 chromicised catgut, the needle taking a bite of firm fibrous structures. Two methods of closure may be recommended in these borderline cases:

(a) The Arbuthnot Lane "X" stitch, which draws the edges of the defect over the peritoneal stump.

(b) A mattress stitch passed on a round-bodied needle, first through Poupart's ligament about $\frac{1}{2}$ inch lateral to the internal ring, under the conjoined muscle, to emerge at the ring, then out through the upper margin of the defect and back through its inner margin, and then back under the muscles to pierce Poupart's ligament again about $\frac{1}{4}$ -inch from its point of entry. This stitch draws the margins of the defect together, and the whole weak area outwards.

(2) *Reconstruction of the Internal Ring.* After ligature of the sac, the cord must be displaced to the outer and upper part of the stretched ring, and held there by a retractor, which at the same time keeps back the muscles and exposes the inner part of the defect. The margins of what should be the ring can be felt more easily than seen, but after identification they may be defined by careful snipping away of loose tags of fascia and muscle. It is essential that the repair material should be anchored at its edges to firm fascial tissue.

(a) *Silk reinforcement.* I personally prefer the use of silk to any other method, as it does not involve dislocation of or injury to any of the normal structures of the canal or its neighbourhood, it is rapid, easy and atraumatic, and it forms the basis of a tough and permanent fibrous sheath. A length of No. 4 Chinese twist silk on a small, curved needle is passed through the inner margin of the stretched ring previously defined, and through Poupart's ligament just below this, and knotted. The short end is caught in a hæmostat. The silk is worked backwards and forwards across the weak area, taking alternate bites of ring margin and Poupart's ligament, and drawn tight enough to lie straight, but not to exert any tension. This darning is continued outwards till the ring is reduced to an opening which exactly fits the cord, lying well out and under cover of the internal oblique. The silk is then knotted on itself and continued back, taking bites of Poupart's ligament between the former stitches and of the transversalis fascia a few millimetres outside the ring margin. When the starting-knot is reached, the two ends of silk are tied together and cut short.

(b) *Fascial strip darning.* A repair, similar in all essentials to that described with silk, may be performed with one or two fascial strips. The strip may be taken from the fascia lata of the thigh with a fasciatome. Alternatively, a ribbon cut from the external oblique aponeurosis, and left attached at one or other end, may be used for the same purpose. I have used a strip cut from the upper leaf, left attached at its outer end, and brought to the internal ring through a tunnel in the muscles, arguing that such a strip would automatically become tense when the abdominal muscles contracted. The belief that any

isolated strip of muscle continues to act as such is probably erroneous, but, at any rate, the repairs carried out by this method have stood the test of time.

(c) *Turner's operation*. Philip Turner repairs a badly stretched internal ring by turning up a flap of fascia lata from the thigh under Poupart's ligament and suturing it to the margins of the defect medial to the cord. Philip Turner (*Guy's Hosp. Rep.*, 13:237, 1933) writes: "The essential feature of the operation is that a pedicled flap of fascia lata with its base at Poupart's ligament is used for the purpose of diminishing the size of the opening and strengthening the fascial boundary of the canal. The flap is turned upwards beneath Poupart's ligament into the inguinal canal, and is sutured to the margins of the gap which have been carefully defined at an earlier stage.... The original deep surface of the flap, which was in contact with the muscles of the thigh, looks forward, while the original superficial surface, in relation with the fatty tissues of the thigh, is now in contact with the extra-peritoneal fatty tissue at the back of the inguinal canal."

In all of the above operations, the cremaster is carefully sutured over the cord, as in the standard operation.¹

COMPLETE RECONSTRUCTION OF THE POSTERIOR WALL OF THE INGUINAL CANAL

I shall now describe four posterior reconstruction operations which may, on occasion, be employed for large oblique hernia in which the margins of the internal ring and of the posterior wall of the inguinal canal are unduly stretched and in which the shutter-like action of the inguinal muscles is lost or partially lost. These operations are illustrated on page 984.

Anterior reconstruction operations are unsound in principle and are associated with a high percentage of recurrences when they are carried out for the type of case under discussion. Bassini's operation, Wyllys Andrews' imbrication operation, and Halsted's rectus sheath flap operation are all widely practised for such cases as these; but in latter years where I have found it inadvisable to employ either the standard operation or a modification of it which involves some partial reconstruction of the posterior wall of the inguinal canal, I have preferred the floss silk lattice repair to the operations which are about to be considered. In other words, where a large oblique inguinal hernia is associated with a wide internal ring, atrophied muscles and a poor sphincteric mechanism, either the floss silk method or Gallie's opera-

¹ Ogilvie, *Post Graduate Surgery*, Medical Publications, Ltd., London, vol. 3, p. 3637, 1937.

tion is likely to be followed by better results than the Bassini type of operation or its modifications.

Bassini's Operation. A straight incision is made a $\frac{1}{2}$ inch above and parallel to Poupart's ligament, extending from a point just lateral to the internal ring to the lower part of the centre of the external ring. The external oblique is exposed and slit up from the external ring to a point about a $\frac{1}{2}$ inch above the internal ring. The edges of the aponeurosis are picked up with artery forceps, freed from the underlying structures and retracted. The cremaster is incised and the hernial sac isolated from the other structures in the cord as far as the internal abdominal ring. The neck of the sac is then transfixed, ligatured and divided. The cord is supported in the loops of Morant Baker forceps and drawn forward, while the interrupted sutures are being introduced (fig. 216 [1]).

The arching fibres of the internal oblique muscle and the conjoined tendon are sutured behind the cord to the inner shelving margin of Poupart's ligament in order to make a new floor in the inguinal canal. In all some five to six interrupted sutures of No. 0 or No. 1 twenty-day chronic catgut or of No. 2 or No. 3 twisted silk are introduced before being tied.

The upper leaf of the divided cremaster muscle and the internal oblique muscle are firmly retracted upward and outward in order to expose the internal ring fully while the first suture is being passed. This stitch takes a good bite through the lower fibres of the internal oblique, just above the ligatured neck of the sac, then passes through the fascial margin of the inner border of the internal ring immediately medial to the cord and then through the curved edge of Poupart's ligament. The ends of this suture are clipped with hæmostats and laid aside while the next suture is being inserted. This suture picks up from above downward the lower fibres of the internal oblique, the upper leaf of the cremaster muscle, the transversalis fascia, the lower leaf of the cremaster muscle, and finally the sharp edge of Poupart's ligament. Three or four other sutures are passed in a similar manner, but the last stitch picks up the conjoined tendon and the inguinal ligament very close to their insertion (see fig. 216 [1]).

When all the sutures are introduced they are tied *seriatim* and their ends are cut short but not too short.

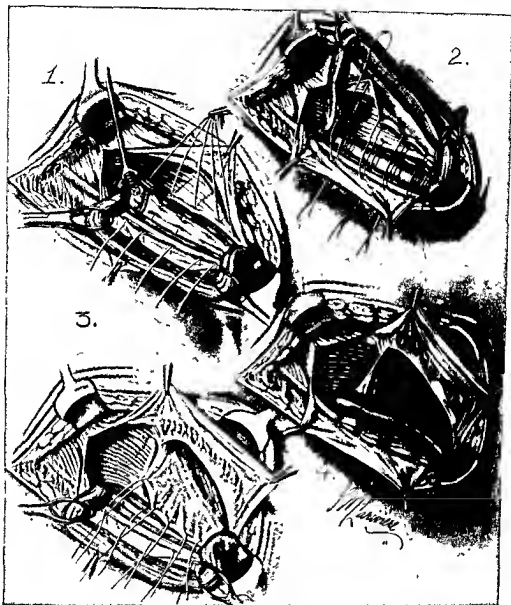


FIG. 216.—FOUR TYPES OF POSTERIOR REPAIR FOR CURE OF INGUINAL HERNIA. (1) Bassini. (2) Wyllys Andrews. (3) Halsted. (4) Bloodgood.

The cord is now laid on its newly constructed bed and the external oblique aponeurosis and skin are sutured in turn. There are, of course, many modifications of this operation, including the overlapping of the flaps of the aponeurosis from above downward in a double-breasted fashion, and the method of suturing of the external oblique aponeurosis behind the cord.

Wyllys Andrews' Imbrication Operation. Wyllys Andrews first described this operation in 1895 (*Chicago M. Rec.*, 9:67, 1895), a further excellent account having more recently appeared in the *Surgical Clinics of North America* (14:919, 1934). It has stood the test of time and is today a very popular operation in many clinics. This skillful method of posterior reconstruction may be readily recommended for those cases in which the tissues are sufficiently good to permit of imbrication of the aponeurotic tissues, upon which, as Andrew has stressed, its success depends.

The skin incision is made in the usual manner, and the external oblique and external ring are exposed. The incision in the aponeurosis is made a little higher than in Bassini's operation—that is, 1 to 1½ inches above the inguinal ligament—in order to provide a fairly large lower flap of aponeurosis. After the sac has been dealt with, the cord is lifted up in the rings of Morant Baker forceps while the sutures are introduced. The first stitch is passed immediately medial to the point where the cord emerges from the internal abdominal ring, and the last stitch is placed at the medial end of the canal and includes a good bite of Gimbernat's ligament. Each stitch (No. 0 or No. 1 twenty-day chromic catgut or No. 2 or No. 3 plaited or twisted silk) is passed first from the deep fascia of the thigh immediately below Poupart's ligament into the inguinal canal (the finger should guard the femoral vessels from injury); then through the conjoined muscles (or tendon) and cremaster from within outward; then back through the recurved edge of Poupart's ligament; then through the upper leaf of the external oblique aponeurosis, not far from its edge, and finally back through the lower leaf of the external oblique aponeurosis, a ¼-inch above Poupart's ligament, to appear on the thigh close to its point of first insertion. This W-stitch is well illustrated the manner depicted in figure 216 (3).

After the last stitch has been inserted, each is firmly tied and the cord is replaced on its newly-formed muscular-aponeurotic bed. The lower leaf of the aponeurosis of the external oblique muscle is then sutured over the cord to envelop it or to form a fibrous roof of the canal, pains being taken to reduce the external ring to the diameter of the cord.

Halsted's Rectus Sheath Flap Operation. The Halsted operation (*Bull. Johns Hopkins Hosp.*, 14:208, 1903) consists of turning down-

ward and outward a semi-lunar flap from the anterior sheath of the rectus muscle to reinforce the posterior wall of the inguinal canal in the manner depicted in figure 216 (3).

Bloodgood's Operation. By this method the anterior rectus sheath is incised for about 2 inches or so and the outer portion of the exposed rectus muscle and its sheath are drawn downward and sutured with the conjoined tendon and internal oblique muscle to Poupart's ligament behind the cord. Reference to figure 216 (4) will make this point quite clear.

I have had no experience of this operation and I dislike it on principle. It is unthinkable that the dislocated rectus muscle, drawn out of its usual line of action, pulled upon by stitches, and with some of its fibres strangled by sutures, will remain fused to the inguinal ligament for any appreciable length of time.

OPERATIONS FOR DIRECT INGUINAL HERNIA

The best operations for direct inguinal hernia are: (1) Gallie's posterior repair by means of strips of fascia lata, and (2) the floss silk lattice posterior repair method.

1. Gallie's Operation. Gallie sutures are usually taken from the ilio-tibial band, either by an open operation or by means of a fasciatome. By the first method an incision about 12 inches long is made over the outer aspect of the thigh down to the fascia lata, and strips of fascia 10 inches long by a $\frac{1}{4}$ -inch wide are removed. The resulting gap in the fascia may be closed with interrupted sutures or left unclosed when the edges cannot be approximated without considerable tension.

There are many disadvantages associated with this method. It is time-consuming, the extensive wound in the thigh may become infected, and if too much fascia is excised it may leave the thigh in a weakened condition or there may even be an obvious hernia of the muscle.

By the second method a fasciatome is used. Small's instrument is ingenious and efficient and is used by most surgeons in this country. It enables the surgeon to cut clean, regular fascial strips of full length with the minimum of trauma. For limited operations, suitable aponeurotic strips may be cut from the tissues in the immediate vicinity

of the operative field. In the repair of inguinal hernia such strips are usually taken from the external oblique aponeurosis.

Gallie's epoch-making operation is best described in his own words. The following is taken from the much quoted and classical account given by Gallie and by Le Mesurier in the *British Journal of Surgery*:

In the case of *direct inguinal herma* the defect in the ordinary Bassini operation has frequently been recognised and many attempts have been made to improve on this operation by filling the defect in the abdominal wall with muscular or aponeurotic structures which might be able to withstand the strain. Thus, the transplantation of a portion of the rectus muscle to Poupart's ligament, the turning down of flaps of the rectus sheath, and the transplanation of patches of fascia lata have all had their advocates. These operations all have the defect, however, that they depend for their success on the healing together of fibrous or muscular structures, a factor which unfortunately cannot be depended upon. None of them, therefore, has ever become recognised as the established method of procedure.

The structures about the inguinal canal are peculiarly suitable for the use of living sutures. No dependence can be placed on a muscle such as the internal oblique, but in the immediate neighbourhood are the abdominal aponeurosis, the conjoined tendon, the sheath of the rectus, and Poupart's ligament, all strong fibrous structures which will give firm anchorage for the suture. With a sufficient number of strips of fascia lata, therefore, the weak spot in the abdominal wall can be filled up completely without any disturbance of the normal anatomical relations and without any dependence on the uncertain process of healing.

From our experience with living sutures a few points in technique have been evolved which are useful. Much time can be saved by having a second operator to secure and prepare the sutures. A few minutes before they are required he makes a long incision on the lateral aspect of the thigh and exposes the fascia lata. The fat and areolar tissues are carefully removed with the blade of a scalpel over the whole area from which the sutures are to be taken. A small longitudinal incision is then made through the fascia, and with a pair of blunt-pointed scissors it is ripped to the required length. This will vary from 9 to 12 inches according to the length of the thigh. A second incision in the fascia is made $\frac{1}{4}$ -inch later to the first, and one end of the suture so prepared is cut free and trimmed to a point. This end of the suture is passed through the eye of a large curved needle, and tied securely after transfixion with fine silk. The needles are very thick, and have an eye which is large enough to allow the strip of fascia to enter easily. The terminal end of the suture is then cut free, and a fine linen ligature is tied around it to prevent splitting. The suture is now lifted from its bed and is ready for use. In taking the first stitch the needle is passed through a tough portion of the edge of the gap to be closed and then through the terminal end of the suture. In this way a slip knot is produced

which forms an excellent anchor. The suture is woven strongly into the edges with as many bites as seem necessary, and passed backwards and forwards across the opening until its whole length is used up. Owing to the slippery character of the fascia it will be found useful to anchor the sutures at every second or third stitch by some form of knot. We usually combine a single loop-knot with transfixion. When the first suture has been used up, a second may be attached to it in the same way as pieces of tennis gut are fastened together, and the sewing continued. In this way one suture after another may be inserted until the opening is completely closed. The suture is finally ended by splitting its terminal portion into two strands which are tied together about the suture in a triple knot. This knot should be made secure by transfixing it with a catgut ligature which will hold its loops in contact until they become firmly healed together.

The wound in the thigh has never given us any concern. Where not more than four sutures have been removed the opening in the fascia can be readily closed with catgut, and there does not appear to be sufficient strain upon it in the ordinary movements of the thigh to cause it to open again. In several instances, however, so much fascia was used that the opening could not be closed, and in these cases no attempt at closure was made. In not a single patient, of the two hundred or more in whom strips of fascia have been removed from the thigh, has there been any complaint of symptoms or any evidence of disability resulting therefrom.

The operation for direct inguinal hernia presents no difficulties. The incision is made so as to allow perfect exposure of the spine of the pubis and the insertion of the conjoined tendon and the rectus sheath. After splitting the external oblique, the upper leaf is reflected until a good view is obtained of the white abdominal aponeurosis. The sac is dealt with in the usual manner, although occasionally we have done nothing with it more than to push it backward out of the way. The first suture of fascia lata, $\frac{1}{4}$ -inch wide, is then anchored securely into the rectus sheath close to its attachment to the pubic bone. The needle is now passed behind the spermatic cord to pierce Poupart's ligament at its insertion into the pubic spine. If possible it should be made to pick up the periosteum to make the security of its fixation more certain. When the suture is drawn taut, the weakest spot in the abdominal wall, namely, that which lies behind the external abdominal ring, is filled with a tough aponeurotic tissue which effectively prevents any bulging through the ring. The sewing is continued in an outward direction, drawing the internal oblique muscle to the reflected portion of Poupart's ligament behind the cord, until the position of the internal ring is reached. Here the suture is locked and then carried to the outer side of the ring, where a supporting stitch is inserted. In this way the cord, at the point where it disappears through the abdominal wall, is surrounded by a fibrous ring which will effectively prevent the development of a hernia at this point. By locking each stitch at this stage the possibility of undue constriction of the cord is prevented. The sewing of the internal oblique

muscle to Poupart's ligament in this manner is a detail of the operation which in our opinion is of very little value in preventing recurrence of the hernia. It is of value, however, in permanently covering the peritoneum with a thick layer of muscle which will prevent the protrusion of peritoneum through the chinks of the next layer of sutures, which is the important one in the prevention of recurrence. This layer commences as a continuation of the first, at the outer side of the internal ring. The needle takes a solid bite of the abdominal aponeurosis at its point of fusion with the external oblique and is then passed behind the cord to pick up Poupart's ligament. The suture is carried backward and forward across the space, with frequent lock-stitches, until the sheath of the rectus is reached, and this also is woven to Poupart's ligament until the whole space is filled with fascia down to the pubic spine. No attempt is made with the second row of sutures to drag the abdominal aponeurosis and the rectus sheath out of their normal positions. No greater tension is exerted on the sutures than is sufficient to make them lie flat. The whole idea of the operation is to fill the weak spot in the abdominal wall with what may be called a filigree of living aponeurosis, and to depend on the strength of this filigree and on its grip on the surrounding tissues for the cure of the hernia. What one does with the external oblique is of relatively little importance. Usually in direct hernia it is too weak to be of any value to the surgeon. In our earlier operations we closed it down to the external ring with a narrow strip of fascia, but in the last four years we have simply sewn it up with catgut. The time which is spent in preventing a hernia from getting out of the canal is much better spent in preventing it from getting into it.²

Technical details of Gallie's operation will be readily appreciated by referring to the accompanying diagram (fig. 217 [1, 2, 3, 4, 5 and 6]). The simple method of anchoring the end of the fascial strip to the eye of the needle is well shown in figure 217 (1a, b and c).

2. **The Floss Silk Lattice Posterior Repair Method.** This posterior reconstruction operation is almost identical with the Gallie method except that silk is used instead of fascia lata, and with the "darn-and-staylace" procedure, which was originally described by Sampson Handley (*Practitioner*, June, 1918). During the last six years at the Southend General Hospital we have employed this method for the majority of our cases of direct inguinal hernia, and so far in our first sixty cases only one recurrence has been noted. We have preferred floss silk to Pearsall's No. 4 Chinese twist silk as suture material. The floss silk which we use is specially prepared for us by Arnold and Sons. The floss silk is boiled for four hours and a long strand,

² Gallie and Le Mesurier, *Brit J. Surg.*, 12, 289, 1924.

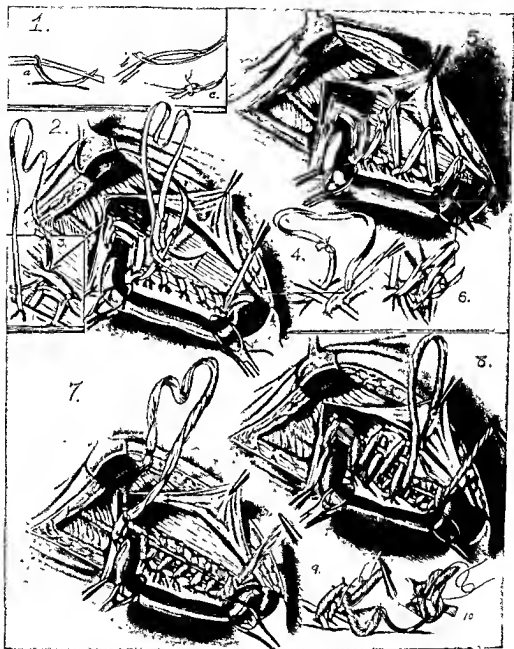


FIG. 217.—OPERATIONS FOR DIRECT INGUINAL HERNIA.

(1) to (6) Gallie's operation.

(7) to (10) the floss silk lattice repair.

some 20 to 26 inches in length, is twisted around a glass rod which is immersed in a hermetically sealed glass tube containing absolute alcohol. Just before use, the silk is immersed in warm normal saline solution and thoroughly rinsed in doubly distilled water to rid it of all traces of the alcohol.

Floss silk is stronger than strips of fascia lata. It remains, of course, unabsorbed in the structures in which it is buried, it produces no tissue reaction, and eventually it becomes incorporated in fibrous tissue.

In conducting this operation we follow the Halsted all-silk technique and insist upon the most scrupulous asepsis, hæmostasis and gentleness. Up to date we have had no post-operative complications such as stitch abscess, hæmatoma, sinus formation, extrusion of the floss silk or frank suppuration of the wound. The final results have been truly gratifying in every respect, and the operation site has, in every instance but one, been strong, supple and cosmetically perfect.

The operation is performed as follows: The skin is prepared with alcohol, and the skin crease incision is used. Tetra-cloths are affixed to the skin margins, after ligaturing the superficial vessels with fine silk and after defining the limits of the external ring and freeing the aponeurosis of the external oblique muscle from all fatty tissues. The external oblique and cremaster layers are divided and reflected, and the external pillars cleared of fatty and muscular strands. It is most important to define the insertion of the inguinal ligament to the pubic spine and to obtain a clear view of the origin of the rectus muscle from the pubis. In the case of a long standing oblique inguinal hernia with an unusually large sac and a wide neck, the sac is isolated from the cord and the neck of the sac is defined at the internal ring, ligatured and divided. In the case of a direct inguinal hernia we make a rule neither to disturb the sac in any way nor to attempt to ligature or invaginate it. The object of the operation is to produce a solid flat uniform fibrous-silk sheet, to protect the whole of the posterior wall of the inguinal canal, and at the same time to provide a suitable aperture for the passage of the cord. This is obtained by constructing a lattice with a 20 inch strand of floss silk threaded on a small, curved, round-bodied trocar-pointed needle. The cord is lifted upward and out of the way in the loops of Morant Baker forceps, and the suture is introduced first of all by taking a good bite of the deep

aspect of Poupart's ligament at its point of insertion into the pubic spine, and then through the lateral tendinous fibres of the rectus muscle, close to its origin from the body of the pubis. The end of the suture is not tied at this stage, but is left long and caught up in the jaws of a hæmostat (fig. 217 [7]).

The suture is now continued in a lateral direction, *i.e.*, toward the internal ring. First a bite of the recurved edge of the inguinal ligament is taken, then each side of the cremaster, then of the conjoined tendon and then back again to Poupart's ligament, and so on. The stitches are placed almost vertical and side by side, and they are not pulled upon tightly in such a way as to strangle the tissues or to drag Poupart's ligament out of its normal alignment; in fact, the floss silk is evenly darned into position on the posterior floor of the inguinal canal without the slightest degree of tension, and actually in some cases there appears even to be a considerable degree of slack.

When the internal ring is reached, the cord is drawn firmly outward and slightly downward by making traction on the Mforant Baker forceps, and the upper and outer margins of the internal oblique are retracted upward and outward. The internal ring, or rather the new internal ring, should always be reinforced, and in placing it as far as possible from the external ring care should be taken not to compress the cord unduly at its point of emergence from the abdomen.

The internal ring is best reinforced as follows: The floss silk is knotted or locked on the curved edge of the internal oblique, just above the reflected cord. It is then carried transversely across above the cord, passed through the internal oblique muscle and knotted or locked, *then passed downward to pick up the edge of Poupart's ligament lateral to the cord, and lastly three sutures are repeated in the reverse direction, being knotted or locked at each angle so that the emerging cord is buttressed and surrounded by a double ring of reinforcing floss silk.* From this point the suture is carried toward the medial end of the canal, as illustrated in figure 217 (8). At the extreme (medial) point of the canal, the free end of the suture is tied to the end which has been left long and steadied with artery forceps (fig. 217 [9 and 10]). The edges of the aponeurosis of the external oblique are then sutured behind the cord, using uninter-

rupted sutures of fine silk, thus placing the cord subcutaneously. The wound is now closed.

In order to avoid the formation of dead spaces in which serum may collect and thus predispose to infection, stitch abscess and so forth, the subcutaneous tissues and the fascia of Scarpa and of Camper on each side of the wound are evenly and accurately approximated with a series of closely placed interrupted sutures of the finest silk. The skin edges themselves are closed with vertical mattress sutures of horse-hair, deknatel or dermic, after which a simple gauze dressing is applied, this being kept in position by a broad piece of flexible elastic strapping. The skin stitches are removed on the third or fourth day, and it is most important to keep the patient in bed for a period of not less than three weeks.

CHAPTER 2

FEMORAL HERNIA

Femoral hernia occurs in both sexes, but is, of course, much commoner in the female than in the male, the proportion being about three to one. It is relatively uncommon in children, boys being more often affected than girls. It is also frequently bilateral. I have never seen a case in an infant. In adults it is commoner on the right side than on the left, although bilateral cases are by no means rarely observed.

The hernial sac presents in the thigh on the medial side of the femoral vein, immediately below Poupart's ligament and lateral to the spine of the pubis. The sac, which is always acquired, is bounded anteriorly by Poupart's ligament, posteriorly by Cooper's ligament, medially by Gimbernat's ligament, and laterally by the femoral vein. After leaving the saphenous opening, the hernial sac tends to ride upward over Poupart's ligament, where it may be mistaken for an inguinal hernia; but it may spread outward or descend downward into the thigh.

The coverings of the sac from within outward are: (1) the peritoneum; (2) the septum crurale; (3) the extraperitoneal fatty tissue; (4) the femoral sheath from the transversalis fascia; (5) the cribriform fascia from the fascia lata, and (6) the deep and superficial fascia and skin.

A femoral hernia rarely presents any difficulty in diagnosis. In the average uncomplicated case the swelling is found on examination to be smooth, small and globular; its neck can be identified below Poupart's ligament and below and lateral to the pubic spine, and when reducible it is often possible to feel the sac or rather its thickened coverings.

In an obese patient a femoral hernia may pass unnoticed for years and may even be overlooked when it is the seat of strangulation. The sac frequently contains a little clear peritoneal fluid. The usual contents are omentum, small intestine, and, on the right side, a portion

of the cæcum. Occasionally a fallopian tube, an ovary, or even the appendix, may occupy the sac.

The most important complication is strangulation, and it has been computed that this is eight to ten times more common in femoral hernia than in inguinal.

Richter's hernia, in which only a part of the lumen of the intestine is nipped by the femoral ring, occurs more often in femoral hernia than in any other variety.

The following conditions have to be considered in the differential diagnosis: (1) inguinal hernia; (2) obturator hernia; (3) saphenous varix; (4) enlarged lymphatic gland; (5) psoas abscess, and (6) lipoma.

TREATMENT

The only satisfactory treatment for femoral hernia is operation. The potential dangers of a femoral hernia are greater than those of inguinal or any other type of hernia. Strangulation, as I have pointed out, is about ten times more frequent in such cases, progresses more rapidly to gangrene owing to the razor-like edge of Gimbernat's ligament, and is more fatal in its outcome.

In my experience there is no such thing as a well-fitting, efficient, serviceable truss for the control of a femoral hernia. "Truss treatment is dangerous as there is no prospect of cure by this means, and usually a truss cannot be fitted to a femoral hernia so as to retain it safely. If the hernia slips by the truss pad, there is great danger of strangulation" (Watson). "A truss should never be ordered, or countenanced if the patient suggests it, except in those rare wide-mouthed and easily reducible swellings, where the age or health of the patient prohibits an operation even under local anæsthesia" (Ogilvie).

OPERATIONS FOR FEMORAL HERNIA

These fall into two groups:

1. *Low operation*, or femoral route, *i.e.*, operations performed through the saphenous opening.
2. *High operation*, or inguinal route, *i.e.*, operations performed through the inguinal canal.

The low operation is a simple procedure which can be quickly performed with the minimum amount of interference. It should be the operation of choice for children, feeble patients, and for the "occasional" surgeon. It is associated with a recurrence rate which varies from 5 to 10 per cent.

The high operation in this country is commonly named after Lotheissen (*Zentralbl. f. Chir.*, 25:548, 1898), although Annandale (*Edinb. M. J.*, 21:1087, 1875) was undoubtedly the first surgeon to employ and to describe the inguinal approach in the radical cure of femoral hernia.

The Low Operation. There is a choice of many incisions; these include the following:

1. *The Oblique Incision.* This is an incision about 3 inches long, which is made parallel to and about 1 inch below Poupart's ligament.

2. *The Vertical Incision.* This is begun a $\frac{1}{2}$ inch above Poupart's ligament and is extended downward for a distance of 3 inches, over the femoral canal and parallel to the femoral vessels.

3. *The Crease Incision.* This is also used in operations for the radical cure of inguinal hernia.

The crease incision is perhaps the best, although in cases of strangulated femoral hernia the vertical incision is to be preferred as it is more direct and entails less dissection of the skin flaps.

After the skin incision has been made, the numerous bleeding points in the subcutaneous tissues are picked up and ligatured, skin towels are placed in position and a search is made for the sac. The hernial sac is enveloped by a large number of various layers, and each of these should be exposed, freely incised, stripped off the sac and pushed in an upward direction toward the neck of the sac. It may at times be difficult to find the sac when it is very small and thin, and when it is deeply placed and covered by a thick pad of fat. There is, however, no mistaking the sac itself once it is reached, as its outer surface is more definite, whiter and more opaque than that of any covering layer, and its lining is shiny and smooth. It is very important to isolate the neck of the sac as high up as possible, in fact the parietal peritoneum above the neck of the sac should in most instances be displayed. To do this the sac should be drawn firmly downward, while the fibrous strands which encircle the neck are divided and brushed aside. A little further dissection with gauze pcl-

lets clipped to the tips of mosquito forceps will bring into view the parietal peritoneum which, in contrast to the sac, is whiter, denser and more fibrous.

Before the sac is opened, the surgeon should remove any strands of fatty tissue which cling to Poupart's ligament, to the pectineal fascia and to the sharp curved edge of the falciform process. The fundus is steadied with artery forceps, opened and emptied, and the neck of the sac—or rather the tongue of peritoneum well above it—is then transfixed, ligatured and cut off. The stump, when released from traction, should disappear from sight, and if it does not do so it should be pushed up the femoral canal into the extraperitoneal tissues.

There are many methods of closing the femoral ring by anchoring Poupart's ligament and perhaps the falciform ligament to the pectineal fascia, including:

1. THE PURSE-STRING METHOD. Marcy (1892) used a purse-string suture which picked up Poupart's ligament at its inner end and passed through Gimbernat's ligament, the pectineal fascia and a portion of the femoral sheath, emerging again through Poupart's ligament near its point of entry (fig. 218 [1]). A similar method was described by Wood (1885) and Bottini (1891) and was also recommended and practised by Coley (1908). Cushing (1888) used two purse-string sutures of silk, the first approximating Poupart's ligament and Cooper's ligament, thus closing the femoral canal, while the second suture partially closed the saphenous opening.

2. CLOSURE BY INTERRUPTED SUTURES. Bassini (1885), after excising the sac as high up as possible, introduced two sutures from Poupart's ligament to the pectineal fascia, picking up Gimbernat's ligament on the way, and five sutures from the edge of the falciform process to the pectineal fascia (fig. 218 [2]). When all these sutures were introduced they were tied one by one, thus effectively closing the femoral ring. Lockwood, in his Hunterian Lecture (1888) recommended a similar method, but stressed the importance of protecting the femoral vein with a finger in the canal, and of picking up a good bite of Cooper's ligament and Poupart's ligament when introducing the sutures. Marchetti (1922) occluded the femoral opening with three or four stout sutures which were passed through the lower edge of the aponeurosis of the external oblique and through Cooper's

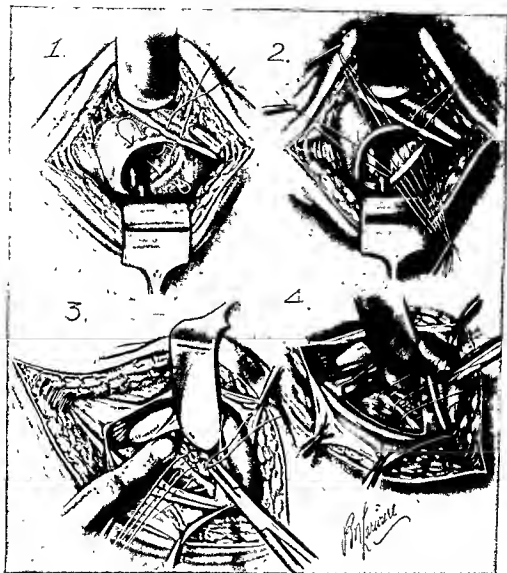


FIG. 218.—OPERATIONS FOR FEMORAL HERNIA.

(1) and (2) show the low operation.

(3) and (4) show the high operation.

ligament, including the periosteum. Payne (1935) used sutures of fascia with excellent results.

The High Operation. The crease incision, which is advocated for operations for inguinal hernia, is employed for most cases of femoral hernia. The aponeurosis of the external oblique, the pillars of the external ring, the lower edge of Poupart's ligament, and the fatty

envelope of the sac are freely exposed; the cribriform fascia is divided, and the enveloping layers of the hernial swelling are individually dissected free in order to isolate the sac.

The outer aspect of the sac—and more especially the region of the neck—should be thoroughly freed of all adventitious structures before the fundus is clipped with artery forceps, steadied and cautiously opened. Omentum, if thickened or inflamed, should be ligatured and excised. Adherent omentum should be freed from its attachments to the sac and any bleeding points secured before it is returned to the abdomen. A knuckle or loop of intestine should be pushed back into the peritoneal cavity by pressure with the tip of the finger. The neck of the sac, which is now completely freed from below, is clamped with artery forceps, and the remainder of the sac is excised. A small retractor should then be inserted under the upper margin of the wound to retract it upward and inward in order to expose the external ring and the aponeurosis of the external oblique. The inguinal canal is now opened by incising the external oblique aponeurosis into the pillars of the ring; the edges of the aponeurosis are clipped with hæmostats and dissected to display the conjoined tendon above and Poupart's ligament below; the cremaster is picked up and divided longitudinally, and the cord or round ligament, stripped from its slender embracing muscular fibres, is held upward in the rings of Morant Baker forceps so that a clear view of the posterior wall of the inguinal canal is afforded.

The strong transversalis fascia, and it is indeed strong membrane in this region, is divided with a knife about $\frac{1}{8}$ to $\frac{1}{4}$ inch above and parallel to the inner aspect of Poupart's ligament for a distance of about 1 inch, and in so doing the epigastric vessels and their large pubic branches must be carefully protected from any injury.

The upper edge of the transversalis fascia is picked up with artery forceps and drawn out of the way while the neck of the sac is sought for by blunt dissection in the loose extraperitoneal fatty and areolar tissues which surround it. The hæmostat which was clamped to and which was steadying the neck of the sac below Poupart's ligament is now released so that this structure can be drawn through the femoral tunnel into the inguinal canal. The edges of the neck of the sac are picked up, freed from the bladder medially, and incised longitudinally on its lateral aspect for its full extent, after which the

parietal peritoneum immediately proximal to the neck of the sac is transfixed, tied off with stout catgut or silk, and cut away $\frac{1}{4}$ inch from the ligature.

The weak spot under Poupart's ligament is buttressed from within, either by suturing the inner end of the conjoined tendon to Cooper's ligament or by stitching the inner end of Poupart's ligament to Cooper's ligament. In this way a shutter is formed, and in my experience it is immaterial whether the conjoined tendon or Poupart's ligament is sutured to the glistening tendon which overrides the ilio-pectineal line.

The arching muscular fibres of the internal oblique and the parietal peritoneum are held aside by a flat retractor, Poupart's ligament is drawn downward, and the surgeon places a finger on the top of the external iliac vein to protect it from injury during the suturing process.

Three stitches of No. 1 twenty-day chromic catgut or No. 3 silk on a small, curved, round-bodied, trocar-pointed needle are inserted through Cooper's ligament. The first suture should lie close to the femoral vein and the last one close to the edge of Gimbernat's ligament or should even pierce a portion of this ligament. All three sutures should, if possible, take a good bite of the periosteum of the ilio-pectineal ridge, in addition to the pectineal ligament itself. Having passed these three sutures through Cooper's ligament, the surgeon may elect to close the hernial opening by carrying the sutures through the inner end of Poupart's ligament as in figure 218 (3), or through the conjoined tendon a $\frac{1}{2}$ inch or so from its free margin, as is depicted in figure 218 (4).

It is best to tie the outermost suture first, after which the remaining two sutures are individually knotted. The cremaster and external oblique aponeurosis are sutured with No. 00 twenty-day chromic catgut or fine silk, and the skin flaps are approximated much in the same way as in the operation for inguinal hernia.

OTHER OPERATIONS FOR FEMORAL HERNIA

1. **Modifications of the High Operation.**—(a) *Gallie's Method.* Here, after the sac has been removed, a long fascial strip is darned backward and forward between Poupart's and Cooper's ligaments, the

suture starting at the pubic spine and continuing outward until the medial aspect of the femoral vein is reached.

(b) *Suture of the Transversalis Fascia to Cooper's Ligament.* As previously pointed out, the transversalis fascia in this region is a dense fibrous sheet, and Dickson (*Surg., Gynec. & Obst.*, 63:665, 1936) has recommended that the upper leaf of the divided transversalis fascia should be drawn down (after it has been freed from the overlying muscular portion of the conjoined tendon) and stitched to Cooper's ligament with three interrupted sutures, the outermost of which should be as near to the femoral vein as is practicable. In his opinion this is all that is required to close off the canal effectively.

(c) *Reinforcement of the Conjoined Tendon by an Aponeurotic Layer.* (i) Wyllys Andrews' method. In this operation the upper leaf of the aponeurosis of the external oblique is brought down behind the cord and sutured with the conjoined tendon to Cooper's ligament in a manner similar to that adopted in the operation for inguinal hernia; (ii) Halsted's rectus sheath method.

(d) *Plugging the Cruial Canal.* (i) With the sac, as advised by Melville (*Brit. M. J.*, 1:467, 1935); or (ii) by auto-transplants.

2. The Extraperitoneal Operation. Lenthal Cheatle was the first to devise the extraperitoneal approach for the radical cure of inguinal and femoral hernia. He writes:

Several cases in quick succession presenting difficulties in the efficient excision of the sac led me to devise a new method by which these and other troubles could be easily and successfully dealt with when they arise.

I approach and reach the back of the inguinal canal from a middle-line incision in the lowest part of the abdominal wall. Unless compelled by some complication I do not open the general peritoneal cavity. All the work is done in a space made in the subperitoneal tissue. I have operated in this way upon forty-one patients. In the first nine I made all the incisions longitudinal. In the remainder I have traversed the abdominal walls by Pfannenstiel's method. I will describe an uncomplicated operation. The patient is placed in the Trendelenburg position and the operator stands on the side opposite the hernia. A transverse skin incision 4 or 5 inches long is made $1\frac{1}{2}$ inches above the symphysis pubis. Its centre corresponds with the middle line. A transverse incision is made in the aponeurosis of the rectus abdominis of both sides, care being taken not to injure either linea semilunaris. The linea alba is undercut upwards and downwards, to within 1 or 2 inches of the umbilicus, and to the symphysis respectively; in doing so the sheath of each pyramidalis muscle will be opened. The opening thus made in the aponeurosis is retracted up and

down and the subperitoneal tissue exposed by separating the abdominal muscles in the middle line. The peritoneum and its contents are pushed up on both sides and if necessary kept up by packing. Two retractors are inserted on the side of operation. The retractors should have long, separate and blunt prongs. The lower retractor, by far the most important instrument in the operation, should pull the abdominal wall downwards, outwards and forwards. Forwards to lift up the abdominal wall. Its prongs should reach the deep epigastric artery and vein. I should not advise anyone to proceed with the operation until he is satisfied that this retractor is in its proper position. The upper retractor pulls the structures outwards. After more completely pushing upwards the outer part of the peritoneum and thoroughly exposing the iliac fascia the neck of the sac can be seen entering the inguinal canal. The deep epigastric artery and vein are delimited and separated from the inner part of the neck of the sac. Cheyne's dissector is a very useful instrument to use for this purpose. The spermatic veins and vas deferens with its vessels are found and separated from the whole length of the exposed sac. These structures are usually on the outer and under surface of the sac. Having cleared the sac it is pulled out of the canal by gentle continuous traction in the direction in which it lies. If there are no indications of the possibility of its easy extraction the sac is cut and the canal portion replaced. (Congenital herniæ would belong to this type.) The neck of the sac including part of the parietal peritoneum is then transfixed and removed. Finally the inguinal canal of the opposite side is examined and if abnormalities exist they are treated on the same lines. I have only once had to ligature a vessel in the subperitoneal space and that was a small branch of the deep epigastric vein.

I will now describe: First, the complications and structures with which I have met. Secondly, the herniæ I would avoid. Thirdly, the herniæ I would select for this operation.

(1) *Complications and structures with which I have met.*—I have found and removed unsuspected and potential hernial sacs from the opposite side in three patients. In others I have cleared from the internal opening of the canal firmly attached dimples of the parietal peritoneum. In others I have removed fibrous cords that passed from the parietal peritoneum into the canals. In the case of one patient the urinary bladder occupied the canal and was practically a part of the neck of the sac. The peritoneum was peeled from the bladder, and the sac was radically excised. When I meet with this complication again I shall distend the bladder with fluid; this will render the separation of herniæ in which the bladder appeared that made me devise some procedure by which I could deal more adequately with this complication. I am sure the operation I have described to you allows the adoption of a complete and safe method. In seven cases I found the urachus, which bore the same relation to the sac as that occupied by the bladder. This was traced to its union with the bladder, and it contained a good deal of unstriated muscle, very tortuous patent arteries, and

some fat. In a few patients I have traced adhesions between bowel and sac, and omentum and sac, into the general peritoneal cavity, which I have been compelled to open to satisfactorily clear them away. The herniæ in these instances appeared to be reducible before operation. The obliterated hypogastric artery was recognised in the sac in three cases. In one of these the lumen of the vessel was not obliterated at the point of section. From one patient I removed a small sac entering the canal and missed a much larger one that was plastered against the iliac fascia and outer part of the inguinal opening. It was this mistake that makes it so essential to expose the iliac fascia. In another patient I had the following unfortunate experience: I had removed the sac on the left side and found an unsuspected sac entering the internal ring on the right side. I congratulated myself on removing these two sacs from the same opening. In six weeks the patient returned with a direct hernia on the right side. Rightly or wrongly I associated my operation with this new hernia and determined to take Mr. Victor Bonney's advice and adopt Pfannenstiel's method of traversing the abdominal wall. As an unusual complication, I may mention that through the same opening I have removed an appendix from a patient who suffered from appendicitis and inguinal hernia.

(2) *The herniæ I would not select* for this operation are direct hernia, irreducible enteroceles, hernia in male children under 7 or 8, and old herniæ in which the internal opening has been dragged down opposite the external.

(3) *Herniæ I would select.*—Those in females of any age, and all uncomplicated inguinal herniæ in males over 7 or 8. I would not exclude irreducible epiploceles.

I may here say that I have approached femoral herniæ by the same method. It has been quite easy. In some cases I have covered the internal opening of the crural canal by turning up a flap of periosteum from the pubes and by turning outwards and upwards a larger periosteal flap from the back of the symphysis pubis. In other cases I have blocked this opening by coiling up into a plug the internal saphena vein which I dissected from the thigh as far as the knee.

It is too soon to report upon the success of these measures of occlusion in femoral herniæ, but all is well so far.¹

A. K. Henry (*Lancet*, 1:531, 1936) also employs the extraperitoneal approach to the femoral region, using a midline sub-umbilical incision. The right rectus muscle is displaced outward above the pubis, and the parietal peritoneum is separated from the abdominal wall in the direction of the crural canal. After exposure of the neck of the sac from above, the fundus is freed by blunt dissection and drawn upward into the extraperitoneal area, after which it is opened, emptied, ligatured at its base and cut off. If the sac is very large it may

¹ Lenthal Cheate, *Proc. Roy. Soc. Med.*, 15-3, 13, 1921; *Brit. M. J.*, 2:1025, 1921.

be emptied of its contents from above, and after this has been done the neck of the sac is divided and closed, leaving the sac plugging the femoral tunnel. Henry closes the canal by turning up a triangular flap of fascia, pedicled in front from the pectineal inuscle, and sutured to Poupart's ligament. But it is just as simple and effective to close the gap by approximating the conjoined tendon or Poupart's ligament to Cooper's ligament. The sutures can be placed with precision and nicety, as an excellent view is obtained not only of Cooper's ligament, Gimbernat's ligament and Poupart's ligament, but also of the all-important iliac vein. Through a midline incision it is of course possible to deal with both sides if necessary.

CHAPTER 3

UMBILICAL HERNIA AND VENTRAL HERNIA

UMBILICAL HERNIA

Herniæ occurring at the umbilicus are of three varieties:

1. **Congenital Umbilical Herniæ.** (*a*) Complete exomphalos, and (*b*) congenital hernia into the cord. These are due to developmental defects in the mid-line.

2. **Infantile Umbilical Herniæ.** These occur in the infant soon after birth when the umbilical cicatrix yields to coughing, straining, vomiting, etc.

3. **Adult Umbilical Herniæ.** These are most frequently seen in obese women over the age of 40.

Exomphalos and Congenital Hernia into the Cord. These should be operated upon during the first twelve hours of life, provided no other gross abnormalities are present. Unless the abdominal wall can be closed before infection supervenes, death is inevitable. At first sight, in some severe examples of exomphalos, the abdominal wall appears to be markedly deficient, but this is, in fact, rarely the case. The abdominal wall is merely displaced and a satisfactory closure can always be effected.

The operation is best carried out under local anæsthesia. The sheath of the two rectus muscles being freely infiltrated with 0.5 per cent novocaine solution, the thin sac is opened and tied off at the point of its junction with the umbilical ring. In order to facilitate reduction of the contents, the wound should be enlarged in an upward direction (never in a downward direction lest the patent urachus or the bladder itself be injured). When the contents have been reduced into the abdominal cavity, the wound should be rapidly closed with a series of through-and-through sutures of stout silk, silk-worm gut or stainless alloy steel wire.

Infantile Umbilical Hernia. Infantile umbilical hernia, unless unusually large is best treated by conservative measures (*e.g.*, strapping)

during the first 18 months to 2 years of life. After this time a natural or spontaneous cure is unlikely to take place.

Elaborate methods of closure of the opening are neither necessary nor advisable. A small curved incision (about a $\frac{1}{2}$ inch below the hernia) is made so as to reflect and preserve the umbilical cicatrix, and the sac is defined and opened, after which the neck is crushed

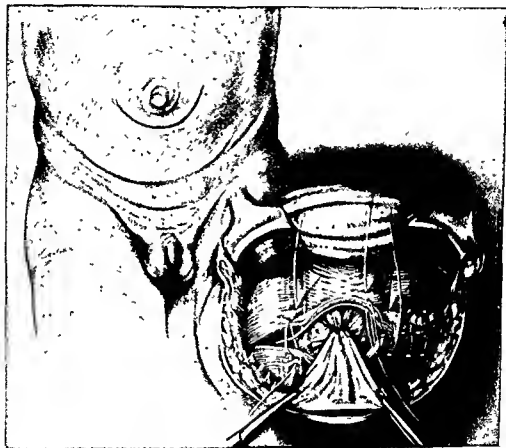


FIG. 219.—OPERATION FOR INFANTILE UMBILICAL HERNIA.

and ligatured with silk or chromic catgut and the redundant portion of the sac cut away. The edges of the aperture in the linea alba are cleared of fatty tissue, freshened, extended laterally by two small cuts through the inner borders of the rectus muscles and are then evenly approximated by a series of interrupted cross-stitches or vertical mattress sutures of silk (fig. 219). The skin flap is sutured back in place and a large gauze pad is firmly strapped over the wound to

prevent the formation of a troublesome hæmatoma. The wound heals well, and after nine months or so the scar is almost invisible.

Umbilical Hernia of Adults. A truss is generally useless for these cases and should be advised only for small and completely reducible herniæ where the risk of plastic repair is considered prohibitive. Strangulation is a common complication and is associated with a high mortality. Most of the patients are middle-aged or elderly, fat, heavy, indolent women who are life-long sufferers from chronic indigestion, chronic constipation and chronic cough, and these are indeed poor subjects for surgery. Much can be done to improve their general condition before operation by strict dieting, regular exercise and mild purgation, and by measures directed to the improvement of their cardiovascular and respiratory systems. Likewise, in order to ensure a reduction in the size and in the tension of the hernia they should be kept in bed for at least a week or two before operation is undertaken.

MAYO'S OPERATION

The transverse overlap method for the radical cure of umbilical hernia was introduced by W. J. Mayo in 1893. The operation should, if possible, be performed under local anæsthesia.

Two longitudinal semilunar incisions are made outlining the hernial swelling, and these are deepened through the fat until the aponeurotic layer is exposed for a wide area above and below the sac. The whole mass of skin, fat and hernia is held up by the assistant while the neck is cautiously cut round with a knife or scissors. The sac is defined and opened near the base of the protrusion, as omental adhesions or adherent gut are less likely to be encountered here than *over the summit*. A finger is introduced into the opening, which is then carefully enlarged by snipping with scissors (fig. 220 [1]). Adherent omentum is dealt with on the usual lines, the colon or small intestine is returned to the abdomen and the entire sac and overlying skin are cut away (fig. 220 [2]). The operation is completed by making the upper aponeurotic edge of the opening overlap the lower. This is performed as follows: The aperture in the linea alba (which is almost circular) is extended on each side by incisions carried through all layers till they expose the inner border of the rectus muscles, thus making the opening transverse. It is important to make these lateral

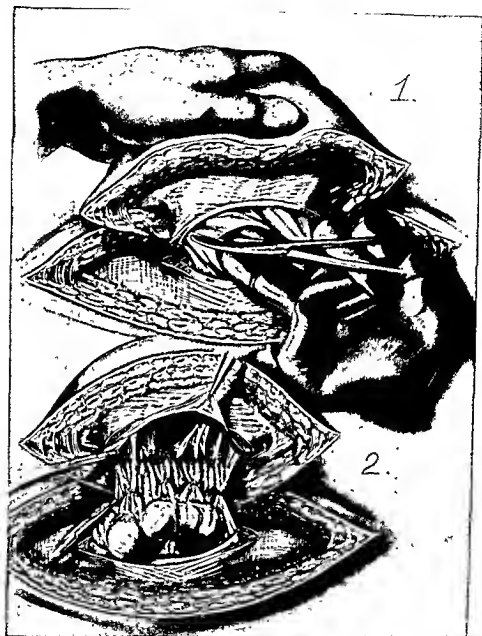


FIG. 220.—MAYO'S OPERATION FOR UMBILICAL HERNIA.

incisions in the ring, otherwise it is difficult to ensure a good overlap.

A series of mattress sutures of strong chromicised catgut or silk are now introduced, the first being passed through the upper flap exactly in the midline about 2 to 2½ inches from its free edge, from without inward; then through the lower flap from within outward,

$\frac{1}{8}$ to $\frac{1}{4}$ inch from its edge, and back through the edge of the lower flap; and then through the upper flap from within outward, a $\frac{1}{2}$ inch to the side of its point of entry. (fig. 221 [3]). Two mattress sutures are similarly inserted on each side of the first one, making five mattress sutures in all (fig. 221 [3]). The five sutures are now drawn tight, thus pulling the entire thickness of the aponeurotic and peritoneal structures well behind the upper flap. The sutures are tied firmly and the long ends cut away about a $\frac{1}{2}$ inch from the knots. The upper flap is now everted in order to expose the suture line and the gaps between the sutures, which are closed with four interrupted catgut or silk sutures (fig. 221 [4]). The free edge of the upper flap is drawn firmly downward and stitched to the aponeurosis below by a continuous suture, as is well portrayed in figure 221 (5).

A piece of corrugated rubber or a drainage tube should be inserted through a small separate stab incision to prevent serum or blood from collecting beneath the long incision. The patient should be kept in bed for at least three weeks, and before being discharged should be provided with a well-fitting corset.

EPIGASTRIC HERNIA

Epigastric hernia is a protrusion of fat (pro-peritoneal lipoma) through an aperture in the supra-umbilical portion of the linea alba. These herniæ vary considerably in size. They may be as small as a pea or as large as an orange.

The larger varieties situated near the umbilicus are best termed *para-umbilical herniæ*.

In the majority of cases the fatty tumour drags a small funnel-shaped process of peritoneum with it through the linea alba. These tumours arise from the fat in the falciform ligament, and carry small blood vessels with them in their extra-abdominal excursion. The symptoms they produce are caused by the dragging on the fat and peritoneum of the falciform ligament. This irritation of the parietal peritoneum causes a reflex pylorospasm which Ryle considers to be akin to the pylorospasm encountered in some cases of appendicular and gall-bladder diseases. The symptoms complained of—eructations, nausea, vague abdominal discomfort and epigastric pain, may be aggravated or relieved by changes of posture. At times there is indiges-

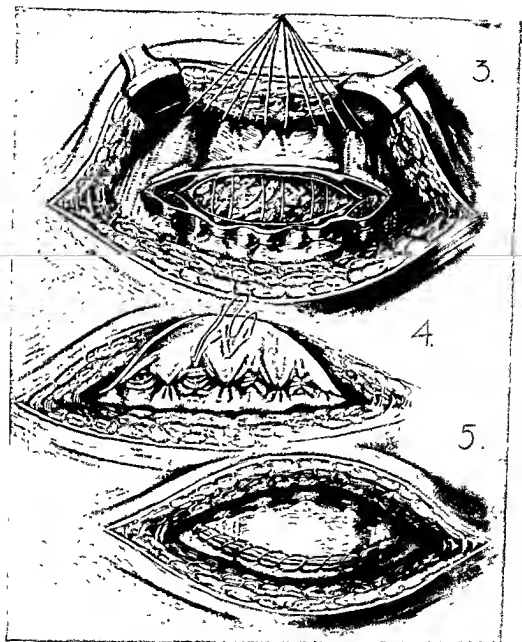


FIG. 221.—MAYO'S OPERATION FOR UMBILICAL HERNIA.

tion of the duodenal-ulcer type, but in some cases vomiting may be the only important symptom. The severity of the symptoms is not wholly dependent upon the size of the hernia; it is largely the outcome of the peritoneal drag or of any concomitant complications. Quite small uncomplicated epigastric herniæ may produce very severe

symptoms and yet pass undetected for many years, particularly in obese patients.

Inflammation or gangrene may arise through the tumour pedicle becoming twisted and producing acute localised epigastric pain, marked superficial tenderness, and muscular rigidity, which would suggest the possibility of an upper abdominal inflammatory lesion, or even a sub-acute perforation. It is possible, too, for a Richter's hernia to occur in the sac of an epigastric hernia, causing symptoms of acute intestinal obstruction, which may even resemble those of acute perforation, acute obstructive cholecystitis or acute pancreatitis. The protrusion is easier to detect when the patient is examined standing than when he is lying down. It is often irreducible and very tender, pain in the lump being the most important diagnostic feature.

If a patient has an epigastric hernia with symptoms, and X-ray pictures exclude the presence of ulcer and gall-bladder disease, the tumour should be dissected out and the breach in the linea alba repaired by a longitudinal reconstruction operation.

VENTRAL HERNIA

Ventral hernia is a protrusion through the anterior abdominal wall occurring at points other than the inguinal, femoral or umbilical openings. There are two main varieties: spontaneous or acquired, and traumatic or incisional.

In the *spontaneous* group are included epigastric herniæ, herniæ of the linea semilunaris, herniæ of the sheath of the rectus muscle, etc., while the *traumatic* group would embrace those herniæ which follow accidental wounds and abdominal incisions.

The factors chiefly concerned in the production of post-operative hernia, such as infection of the wound, prolonged drainage, inept methods of suturing, lengthy incisions through the outer border of the rectus muscle, burst abdomen, healing by granulation, etc., have already been considered (see pages 48-64).

OPERATIONS FOR INCISIONAL HERNIA

These are legion, but may be grouped as follows:

1. Repair of the abdominal wall, as in a primary laparotomy—so-called anatomical reconstruction method.

2. The overlap method as in Mayo's operation for umbilical hernia.

3. Suture of the defect in the abdominal wall by means of fascia lata transplants or sutures (Gallie's method) or by Rehn's method of dermal patch transplant.

The ideal method is to excise the scar tissue freely until the normal structures are exposed and then to reconstruct the abdominal wall as accurately as possible by stitching together its different layers. The technical details of the operation vary according to the situation of the hernia. Thus when the hernia occurs through a gridiron incision, as it may do following an operation for suppurative appendicitis which has necessitated prolonged drainage, the scar is excised, the peritoneum is dissected back from the thickened edges of the muscles, opened to free adherent intestines and omentum, and then closed with a continuous suture. The scarred edge of aponeurosis and muscular tissues is next trimmed so that the aponeurotic sheath can be separated from the underlying internal oblique and transversalis muscles. The muscle layers are approximated with interrupted sutures and the aponeurosis with a running stitch. Then, after drawing the subcutaneous tissues together with fine plain catgut sutures, the skin edges are united in the usual manner.

If the hernia is unduly large and the musculature and fasciæ are very thin, the surgeon should work on the lines of Mayo's operation for umbilical hernia, *i.e.*, after dealing with the hernial "sac" the flaps should be overlapped for a distance of 1 to 3 inches. The edge of the inner flap is sutured to the deep aspect of the lower flap, after which the free edge of the lower flap is fastened to the anterior surface of the aponeurosis of the inner flap by a continuous suture.

Large post-operative herniæ with extensive loss of substance are best treated by the method of darning the area with fascial sutures. One layer of sutures is used to approximate the edges, and a second layer is then inserted, taking a bite of the aponeurosis a $\frac{1}{2}$ inch further out. This second layer reinforces the first and relieves it of all strain.

Midline Sub-Umbilical Incisional Hernia. Nuttall's rectus transplantation method can confidently be recommended for cure of this type of rupture. The hernia frequently follows a sub-umbilical median or paramedian incision for some gynaecological operation,

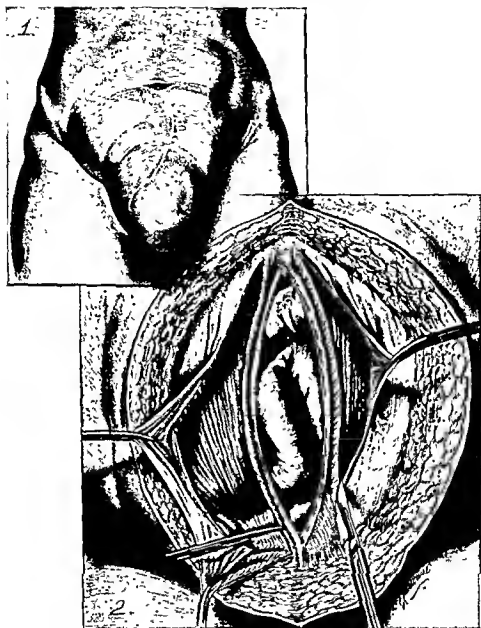


FIG. 222.—NUTTALL'S OPERATION FOR MIDLINE SUB-UMBILICAL INCISIONAL HERNIA.

e.g., hysterectomy. The swelling varies considerably in size and shape. It may be circular, oval or sausage-shaped; it may be small and lie wholly above the symphysis, or it may be pendulous and as large as a football, and be seen hanging downward over the vulva and over the upper part of the thighs (fig. 222 [1]). The overlying skin is

usually scarred, thin, papery, and ulcerated in patches. Coils of small intestine may be identified by their shape and writhing movements, and may be partially or wholly reducible. The neck of the sac may be a large hole or a narrow ring-like structure, one portion of which is commonly formed by the symphysis pubis itself.

At first sight these cases appear to be unsatisfactory for any form of treatment. A truss, abdominal belt or corset is useless in most cases, and dangerous when the complete reduction of the contents is not feasible. The patients are usually fat and in a poor state of health, many of them are bed-ridden, and depressed as the result of several unsuccessful attempts to cure the hernia and from the discomfort or pain which is occasioned by recurrent attacks of partial obstruction. Yet, it is possible to effect a permanent cure in almost every case by Nuttall's operation (*Brit. M. J.*, 1:138, 1936; and *Brit. J. Surg.*, 25:344, 1937). In a personal series of 16 cases, all operated upon within the last three years, there have been no recurrences to report up to the present time.

The technique of this operation will be readily appreciated by referring to figures 222 and 223.

Two crescentic incisions meeting just below the umbilicus and above the symphysis are used, and the skin and fat are reflected on either side for a sufficient distance to expose the lower halves of the rectus muscles and their sheaths. The sac is opened, any redundancy is cut away, adherent omentum or bowel is detached as may be necessary, and the edges of the peritoneum are sutured with a continuous stitch. The rectus sheath is then carefully reflected from the muscle on either side, and the sheaths are separated laterally in order to expose the outer border of the muscle and to afford a good view of the origin of the muscle from the pubis and symphysis (fig. 222 [2]).

Each rectus muscle is then detached from its origin as close to the bone as possible and without interfering with its nerve supply. The tendon of the left rectus muscle is now drawn downward to the opposite side of the pubis and sutured to the ligaments and fibrous tissues here, as depicted in figure 223 (3). The opposite muscle is then sutured in the manner shown in figure 223 [4], and a series of interrupted sutures is next inserted along the edges to maintain good apposition of the over-lapping muscles. The margins of the aponeurotic sheath on either side are then brought together in the

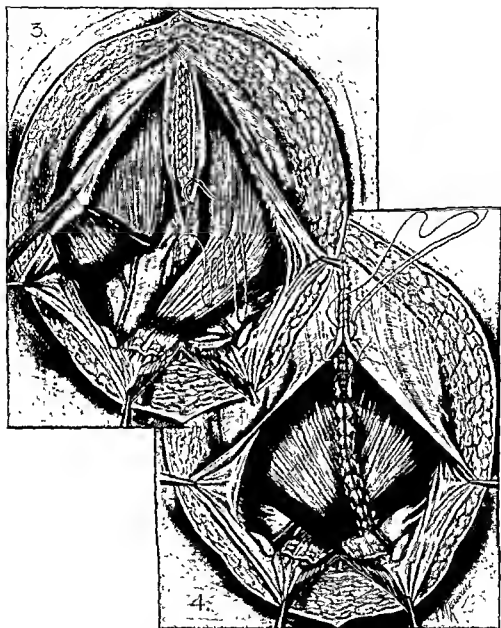


FIG. 223.—NUTTALL'S OPERATION FOR MIDLINE SUB-UMBILICAL INCISIONAL HERNIA.

middle line by a continuous suture or by a series of interrupted sutures, thereby completely obliterating the triangular gaps on either side at the outer border of the rectus muscles. Hæmostasis in the subcutaneous tissues must be complete, and all dead spaces must be obliterated before the skin is sutured. The patient should be kept in bed for three weeks, but after the first week gentle exercises should be commenced. There is no necessity for the patient to wear an abdominal belt subsequently.

CHAPTER 4

STRANGULATED EXTERNAL HERNIA

A hernia becomes strangulated when the blood supply of its contents is arrested by constriction of the supplying vessels.

Strangulated external hernia is the commonest cause of intestinal obstruction. Statistics show that it accounts for 40 to 50 per cent of all cases. Thus in Vick's series of 6,892 cases of acute intestinal obstruction (*Brit. M. J.*, 2:546, 1932) there were 3,267 instances of strangulation, and in McIver's series of 335 cases (*Arch. Surg.*, 25:1101, 1932) there were 147 cases—44 per cent.

The relative frequency of the different types of external abdominal hernia and the incidence of strangulation is given in the following table (page 1018).

McIver (*Am. J. Surg.*, 20:1933) states that strangulation occurs in 2 to 4 per cent of inguinal, in 25 to 30 per cent of femoral, in 15 to 20 per cent of umbilical, and in 3 to 5 per cent of incisional herniæ, and this estimate is in many respects similar to that given by Beller and Colp in 1925.

The frequency of strangulation in femoral hernia is explained by the small size and unyielding nature of the crural canal, and by the sharp edge of Gimbernat's ligament. Similarly, umbilical herniæ are susceptible on account of the rigid fibrous tissue round the neck of the sac and of the hypertrophy of the contained omentum. The relative freedom from strangulation of inguinal and post-operative ventral herniæ is due to the larger size of the neck and to the more pliant character of its surroundings. Nevertheless, owing to the enormous preponderance of inguinal over other types of hernia, the chances are that of any 100 cases of external strangulation, about 50 will be inguinal, 40 femoral, and 10 umbilical, incisional, or one of the rarer varieties.

Although strangulated external hernia is encountered principally between the ages of 30 and 60, it may nevertheless occur in infancy or in old age.

TABLE I
THE INCIDENCE OF HERNIA AND STRANGULATION (Wangensteen)

	Date	Total No. of Cases	Inguinal			Femoral			Umbilical			Incisional		
			No of Cases	Per Cent	Strangulated, Per Cent	No. of Cases	Per Cent	Strangulated, Per Cent	No. of Cases	Per Cent	Strangulated, Per Cent	No. of Cases	Per Cent	Strangulated, Per Cent
Beller & Colp	1925	4139	3208	77	4.0	291	7.0	32	167	4.0	15.0	377	9.0	3.0
Erdmann	1927	2587	2300	89	1.8	97	3.7	25	29	1.1	17.2	145	5.6	5.5

The sex incidence varies with the type. Frankau (*Brit. J. Surg.*, 19:176, 1931) has shown that strangulated inguinal hernia is eight times more common in men than in women, and that strangulated femoral and umbilical herniæ affect women more often than men in the ratios of 4 to 1 and 6 to 1, respectively.

Strangulation may occur at the first descent of a hernia into a congenital sac, but more often it complicates a previously existing and reducible or partially reducible hernia. In certain instances strangulation may be caused by: 1. The rapid or gradual descent of additional contents into the sac.

2. A rapid or gradual increase in the contents of the sac; or

3. External violence, *e.g.*, repeated attempts at reduction.

Acute intestinal obstruction is almost invariably seen in association with the condition, although in Richter's hernia and in epiplocele it may be tardy in appearance. The obstruction is mostly mechanical, the strangulated coil of intestine being occluded by the constricting agent, *e.g.*, Gimbernat's ligament, but at times the ileus is paralytic and due to reflex stimulation of the sympathetic, *e.g.*, strangulation of an epiplocele. The small intestine is present, either alone or with omentum, in 85 per cent of inguinal, 80 per cent of femoral, and 60 per cent of umbilical strangulations. Omentum alone (epiplocele) is found in 17 per cent of femoral and approximately 8 per cent of inguinal and umbilical strangulations. The colon rarely occupies the sac of an inguinal hernia (6 per cent) or a femoral hernia (2 per cent), but it is frequently present in umbilical herniæ (30 per cent). Still rarer contents are the urinary bladder, the vermiform appendix, a Meckel's diverticulum (*Littré's hernia*), and the pelvic organs.

The sites of strangulation and of the constricting agent vary with the type of hernia. In inguinal hernia the constricting mechanism may be: (1) the pillars of the external abdominal ring; (2) the internal abdominal ring; (3) the condensed fibrous tissue around the neck of the sac; or (4) a band or membrane within the sac itself.

In femoral hernia the constricting agent is the knife-like edge of Gimbernat's ligament or the dense bands of adhesions which encircle the neck of the sac, while in umbilical hernia the hard ring of aponeurotic tissue which forms around the neck of the rupture is mainly responsible.

When a coil of intestine is ensnared and strangulated at a hernial

orifice it passes through three fairly distinct morbid stages. The stages are not sharply demarcated; nevertheless, at operation they are discernible from one another and provide a good guide in so far as the management and the prognosis of the lesion are concerned.

Stage 1—The Stage of Viable Gut. As a result of the interference with the venous return the portion of gut ensnared becomes congested, swollen, œdematous, and dark red or purple in colour. Although engorged with blood and distended by gases which it cannot absorb, it retains its shape and its elasticity, its power of peristalsis and its smooth and shiny appearance. The arteries can be felt pulsating in its mesentery. The fluid in the hernial sac is at first clear and sterile, but later on it becomes blood-stained.

Stage 2—The Stage of Non-Viable Gut. The chief feature of this stage is hæmorrhagic infarction of the strangulated intestine. The distended veins of the turgid intestine burst, and the extravasated blood permeates the gut wall, pours into the lumen of the bowel in large amounts, and tightly distends the hernial sac. The intestine will be seen to be black, dark grey, greenish-grey or chocolate coloured. It has lost its shine and elasticity and is incapable of peristalsis. The exudate in the sac may be blood-stained or muddy, and possess fæculent odour. It is often teeming with virulent micro-organisms. The arteries in the mesentery cease to pulsate and decomposition sets in.

Stage 3—The Stage of Gangrene. The whole of the strangulated loop or portions of the devitalised gut now become gangrenous. Necrosis generally starts at one of two points: either at the sites of constriction, or at the apex of the loop at the anti-mesenteric border. Later on the necrotic process involves the whole loop.

Perforation of the gangrenous gut is followed by the formation of an abscess in the sac. This abscess may burst externally, and the resulting fæcal fistula at times leads to a spontaneous cure of the condition. In a number of cases, although the loop as a whole is viable, anæmic lines or ulcerative patches occur at the points of constriction. At operation, unless the affected loop and a few inches of intestine both proximal and distal to the site or sites of constriction are pulled down and carefully inspected, these localised patches of necrosis may be overlooked, with the result that perforation may develop as an early or late sequel, leading to diffuse peritonitis or fibrous stricture.

The intestine proximal and distal to the strangulated segment shows the changes typical of acute obstruction.

SOME RARE TYPES OF STRANGULATED HERNIA

Epiplocele, or strangulated omentum, rarely becomes frankly gangrenous. It sometimes leads to paralytic ileus owing to reflex stimulation of the sympathetic.

Partial enterocele (or Richter's hernia) occurs, according to Frankau, in about 10 per cent of strangulated femoral herniæ. It is a serious and treacherous type of strangulation. The hernial protrusion, being small, may be overlooked, and as the obstruction is only partial the symptoms in the early phases may be mild and even misleading. Gangrene and perforation rapidly ensue, however, when the herniated portion of the intestinal wall becomes tightly nipped by the unyielding ring. Less than a third of the cases are diagnosed within the first forty-eight hours of strangulation, and the death-rate is over 30 per cent.

Retiograde strangulation (or Maydl's hernia) is a hernia of W formation, with two loops in the hernial sac and an intervening loop in the abdomen; the latter loop becomes strangulated owing to kinking or compression of its mesentery.

Clinical Features. The signs and symptoms of strangulated external hernia are those of intestinal obstruction with in addition the presence of a painful, tender and often tense swelling at one of the hernial orifices.

The type of obstructive symptoms will vary according to which portion of gut becomes obstructed in the hernial sac. If the jejunum is entrapped, the symptoms will be very acute; if the ileum, the manifestations will be somewhat modified; while if the colon alone fills the sac the symptoms may be comparatively mild in character, although none the less serious. When the omentum alone is caught up in the hernial orifice there will be pain, nausea, constipation and sometimes vomiting, but the obstruction is never absolute, and evacuation of the bowels may be effected by means of enemata.

In the average case the obstructive symptoms are characteristically those of low small-gut obstruction, that is, intermittent bouts of colicky abdominal pain, frequent vomiting, and complete constipation—

no flatus or fæces being passed. Collapse, dehydration, toxæmia, low blood pressure and distension of the belly are late manifestations and must not be awaited. In neglected cases all the above symptoms will be present, and also other associated complications, of which high blood urea and scanty urine are the most important. The abdominal diagnostic sign is increased peristalsis which can be easily discovered on auscultation. In late cases the absence of this sign is of serious significance, implying, as it does, paralysis of the intestines.

The local swelling is situated over a hernial opening. In most cases a history of previous reducibility can be obtained, but occasionally strangulation may be the first intimation of the presence of such a protrusion. With the onset of strangulation the hernia becomes irreducible, tense and tender, and there is no impulse on coughing. The contents of the sac can sometimes be determined by percussion. The imprisoned bowel may yield a tympanic note which may be damped when the sac is filled with fluid. It is, however, never so dull as the percussion note produced by incarcerated omentum.

Wangensteen (*Bowel Obstructions*, 1937) states that the presence of gut in the sac can frequently be demonstrated by a lateral or oblique X-ray film.

When the ensnared gut becomes gangrenous the swelling becomes less tense and less tender, but there is still no impulse on coughing. If the patient survives long enough, the skin over the rupture will gradually become swollen and acutely inflamed, until finally it sloughs away, giving rise to a fæcal fistula and perhaps to a cure of the disease.

Differential Diagnosis.—1. *Strangulated Inguinal Hernia*. This must be differentiated from: (a) irreducible hernia; (b) inflamed hernia; (c) incarcerated hernia; (d) acute hydrocele of the cord; (e) inflamed inguinal or iliac glands; (f) torsion or inflammation of an inguinal testicle; (g) thrombosis or phlebitis of the veins of the pampiniform plexus.

2. *Strangulated Femoral Hernia*. This may be confused with: (a) adenitis of the femoral glands; (b) thrombosis of a saphenous varix; (c) the tense and painful hydrocele of a femoral hernial sac; (d) an inflamed appendix in a femoral hernial sac; (e) a strangulated inguinal hernia, or (f) a strangulated obturator hernia.

A strangulated obturator hernia is very rarely diagnosed prior to

exploratory laparotomy, but Wakeley (*Brit. J. Surg.*, 26:515, 1939) has pointed out that the condition should be suspected if on rectal or vaginal examination a tender lump can be identified above the inferior ramus of the ischium. Constant and severe pain along the inner side of the thigh as far as the knee (Howship-Romberg sign) corresponding to the sensory supply of the obturator nerve in a patient with signs and symptoms of intestinal obstruction, is strongly suggestive of strangulated obturator hernia. Of 396 cases of obturator hernia that were collected by Watson, the vast majority were strangulated.

3. *Strangulated Umbilical Hernia.* Cope says that the two commonest mistakes made in connection with umbilical hernia are:

(a) Overlooking a small hernia deeply embedded in fat; and

(b) Assuming that the hernia is not strangulated because the symptoms are not very acute.

The fact that the death-rate for strangulated umbilical hernia is three to four times higher than that for strangulated inguinal and femoral herniae shows the great need for early diagnosis and prompt surgical interference.

Prognosis. Over 2,000 individuals die annually in Great Britain from strangulated hernia. The death-rate is, however, lower than that of other obstructive lesions. Braun and Wortmann's 1,196 cases (1924) show a mortality of 15.6 per cent, Vick's 3,267 cases (1932) of 17.8 per cent, and Frankau's 1,487 cases (1924) of 15.7 per cent. The average mortality of internal obstruction is about 40 per cent. The prognosis in strangulated external hernia depends to a large extent on the duration of strangulation before operation—the time factor.

Here are the statistical figures compiled by Frankau (*Brit. J. Surg.*, 19:176, 1931) (page 1024):

These figures show that the death-rate from inguinal and femoral strangulation is multiplied more than five times by delaying operation beyond the first twenty-four hours. The reason for this is that in the late cases the gut is almost invariably devitalised or frankly gangrenous, and such measures as resection, exteriorisation, etc., are essential in order to save life.

In Frankau's series of cases resection was performed 105 times with forty-five deaths (42.8 per cent), while in Braun and Wortmann's series 286 resections were followed by 144 deaths, a mortality of 50.9

TABLE 2
COMPARISON OF DURATION AND MORTALITY OF
STRANGULATED HERNIA

Variety	Duration of Strangulation	No. of Cases	Deaths	Mortality Per Cent
Inguinal	0-24 hours	113	25	6
	over 24 hours	161	18	30
Femoral	0-24 hours	269	10	3.7
	over 24 hours	320	66	20.6
Umbilical	0-24 hours	39	14	23.7
	over 24 hours	66	36	54.4
Total	0-24 hours	741	49	6.6
	over 24 hours	547	150	27.4

TABLE 3
PROGNOSIS

	1st Day Per Cent	2nd Day Per Cent	3rd Day Per Cent	4th Day Per Cent	5th Day Per Cent
Inguinal strangulations ...	6	15	28	40	36
Femoral strangulations	3.7	18	23	16	27

per cent. In 1,509 cases in which no gangrene was present, the German surgeons reported a death-rate of only 9.0 per cent. A number of statistics published in 1939 show almost identical death-rates.

Other factors bearing on the prognosis of strangulated hernia are: (1) the age and general condition of the patient; (2) the type, size, contents and position of the hernia; (3) the length of intestine involved; (4) the intensity of the constriction; (5) the management of the cases before and after operation; (6) the anæsthetic employed; (7) the actual operative procedure, and (8) the incidence of post-operative complications.

Treatment. Every case of strangulated hernia demands immediate

operation under appropriate anæsthesia. The only alternative to operation is reduction by taxis. Taxis, which is a dangerous procedure, is only justifiable when the patient refuses operation. The dangers of taxis are:

1. The entire sac and contents may be displaced into a position between the layers of the abdominal wall.

2. The hernial sac may be ruptured and the contents be forced into the scrotum or abdominal wall.

3. The intestine may be ruptured or severely bruised, the reduction being followed by acute peritonitis.

4. The gut may be reduced, but on its return to the abdomen it may rotate on its mesenteric axis and so produce a volvulus.

5. The gut may be non-viable, and its replacement into the abdominal cavity may be followed by perforation and general peritonitis.

"Reduction en masse" is obviously an extremely dangerous complication, as it tends to suggest a cure when it is really an aggravation of the lesion. It should be suspected, or rather diagnosed, if an apparent reduction is followed by pain, shock, or persistence of the obstructive symptoms. Here the only chance of saving the patient's life depends upon immediate operation under local anæsthesia, but even so the death-rate is very high.

Operation should be proceeded with even where during the induction of anæsthesia there appears to be—or actually is—a complete reduction of the hernial contents.

Pre-Operative Preparation. For early cases, *i.e.*, for those admitted to hospital within twelve hours of strangulation, no special pre-operative treatment is required. The skin is prepared, and a suitable pre-anæsthetic is administered before the patient is removed to the operating room.

For cases seen after the first twelve hours, an hour or so should be spent on pre-operative treatment.

The following measures are advocated:

1. *Anti-shock Treatment.* Morphia, gr. $\frac{1}{4}$, and scopolamine, gr. $\frac{1}{150}$, is injected subcutaneously; heat is applied to the abdomen; and normal saline solution with 5 per cent glucose is slowly run into a vein, the drip being continued during the operation and for a variable period afterward.

2. *Blood Transfusion.* This is often a life-saving measure. It not only replaces the blood lost—which may be considerable if the hernia is large—but it helps to combat shock and toxæmia.

3. *Duodenal Drainage.* A catheter is passed by the nasal or oral route, and is used for aspirating the contents of the stomach and upper coils of the small intestine. This measure is of great value, since it prevents air swallowing and the inhalation of vomit, and at the same time decompresses the distended bowel above the strangulation, thus maintaining its tone and blood supply and avoiding paralytic ileus and distension necrosis.

4. *Catheterisation.* The patient should be catheterised shortly before the operation is started.

5. *Enemata.* No aperients or enemata are given immediately before operation.

Anæsthetic. Local anæsthesia is the method of choice (see page 970). In those few cases where the local anæsthetic does not appear to be wholly effective it may be supplemented with gas and oxygen. If for one reason or another local anæsthesia is contra-indicated, a spinal anæsthetic should be given, always provided that the patient is not suffering from shock and has not a low blood pressure.

OPERATION—GENERAL PRINCIPLES

The general principles governing the various steps of the operations for inguinal and femoral strangulation are the same. Thus:

1. **The Incision.** This should be ample so as to afford easy access to the sac and the constricting agent, and should be made either over the hernial protrusion or just to one side of it.

2. **The Exposure and the Opening of the Sac.** All the structures are incised down to the sac, which is carefully separated from its coverings. Using the flat of the blade, the sac is cautiously opened at the fundus in order to avoid injury to the presenting distended intestine. When the sac is opened there will be an escape of fluid, and its glistening endothelial lining will be seen. The fluid contained in the sac may be teeming with pathogenic bacteria. It is important therefore to mop up this fluid as soon as it escapes, and to prevent it from entering the abdominal cavity or spilling over into the subcutaneous tissues. When the fluid is blood-stained, particular care must

be taken in handling the intestine, as this is likely to be very friable.

3. **The Division of the Constricting Agent.** The sac is slit open right up to the neck, and the contents are inspected. No decision as to the further steps of the operation can be made until the constriction has been released by division or stretching of the constricting agents. This release must be sufficient to permit of the free withdrawal of the strangulated coil of intestine or omentum.

4. **Is the Gut Viable?** The strangulated coil and the intestine above and below it are very carefully drawn downward into the wound and examined critically, special attention being paid to the site or sites of constriction. If the gut is obviously viable, it is immediately returned to the abdomen without further ado. But, if any doubt exists, the loop of gut is covered with a towel wrung out of hot normal saline solution and is examined again after five minutes.

Is the gut viable, doubtful, or non-viable?

Viable intestine quickly regains its pinkish or reddish colour evenly throughout its entire length; the arteries in its mesentery can be felt pulsating; its surface is smooth and glistening; and there are no patches or rings of anæmia or necrosis at the sites of constriction; it retains its shape, and is elastic to the feel.

The intestine is *doubtful* when the colour returns slowly and unevenly; when it has lost its normal shine; and when the constricting rings remain clearly outlined on its surface or show small linear patches of anæmic ulceration.

Non-viable intestine is black, grey or chocolate in colour; it has lost its glossy sheen; it looks dull, swollen and œdematous; it is inelastic—like wet blotting-paper; the vessels no longer pulsate in its mesentery; and there may be areas of necrosis at the apex of the loop or where the constricting agent has cut deeply into the bowel.

5. **Radical Cure.** When the patient's condition permits, the operation is completed by a radical cure of the hernia.

OPERATIVE TECHNIQUE IN THE VARIOUS TYPES OF STRANGULATED HERNIA

1. **Strangulated Inguinal Hernia.** The crease incision may be employed (see page 996), but it is more usual to make an incision about 3 to 3½ inches long over the long axis of the tumour, starting 1 inch

above the internal ring and finishing at the widened neck of the scrotum. The inguinal canal is opened wide and the various structures which envelop the sac are incised and pushed aside. The sac is then identified and opened, and a finger is passed up the canal toward the internal ring, either inside or outside the sac, the site of constriction is found, and this is stretched or divided. Quite frequently, however, the pillars of the external abdominal ring constitute the constricting mechanism and can be quite easily divided early in the operation when the external oblique aponeurosis is incised. Any omentum is transfixed, ligatured and removed. The loop of gut is pulled down and the site of the constriction is inspected. If it is found to be viable, it is immediately returned to the abdominal cavity.

The return of the intestine may be rendered difficult on account of distension or because a second constriction is present higher up. Therefore, before the surgeon attempts to return the intestine he should make quite sure that there is no obstacle to reduction. Flexing the thigh to relax the inguinal canal and deflating the intestine by squeezing it gently with a swab soaked in warm saline solution will facilitate the reduction of the viable coil. Other obstacles to reduction which may have to be dealt with are hour-glass constriction of the sac, an interstitial sacculus or an inguinal testicle.

The operation is completed by stripping the sac from the cord, displaying the neck of the sac, dissecting and cutting the sac away after its neck has been transfixed and ligatured, and carrying out the most suitable type of posterior repair to safeguard against recurrence.

2. Strangulated Femoral Hernia. The high operation or inguinal route is preferable to the low operation or femoral route for these reasons: (a) the inguinal approach facilitates division or stretching of the constricting agent; (b) the accessory obturator artery can be seen and avoided with certainty; (c) should resection of the intestine prove necessary it can be carried out with greater ease and safety, and (d) the operation for radical cure can be performed more satisfactorily when the floor of the inguinal canal is exposed.

The crease incision may be employed, but where the hernia is large it is wiser to make a long vertical or oblique incision over the swelling, starting $1\frac{1}{2}$ to 2 inches above the inner end of Poupart's ligament and extending downward to a point 1 inch or so below the protrusion. The covering layers are divided and dissected off the sac,

after which any constricting fibres at the saphenous opening are gently stretched or snipped with scissors. The sac is very cautiously opened near the fundus, the contained fluid is rapidly mopped up, and the contents are inspected.

The external oblique aponeurosis is next exposed and incised, and the pillars of the external ring are split apart. Each edge of the aponeurosis is clipped with a hæmostat and freed from the underlying structures; the cremasteric layer is divided longitudinally, and the cord is picked up in the rings of Morant Baker forceps and drawn away from its bed. The dense transversalis fascia is seized and divided well to the inner side of the epigastric vessels.

The crural ring is now clearly exposed from above and can be enlarged by stretching with the finger, assisted by division of Gimbernat's ligament and of the fibrous compressed bands of tissue in front of the ring. The neck of the sac is now cleared of fatty tissue and opened above Poupart's ligament, and the contents of the sac are gently pushed upward into the inguinal canal. If the intestine is friable and distended there may be some difficulty and anxiety in the process of coaxing it through the ring into the inguinal portion of the wound. Under no condition should force be used, as the gut is very liable to be torn. In those cases where the ring is not sufficiently capacious to ensure the safe transmission of the engorged loop of intestine, I prefer to divide Poupart's ligament or to detach it from the pubic spine as close to the bone as possible, as advised by Hey Groves (*Brit. J. Surg.*, 10:529, 1922).

After dealing with the intestine, the cut ends of Poupart's ligament are sutured, or, if the Hey Groves' operation is employed, the inner end of the ligament is fastened to the dense membrane which covers the ileo-pectineal line, the neck of the sac is ligated, the sac cut away, and a radical cure is effected by stitching the conjoined tendon to Cooper's ligament and by approximating the edge of the aponeurosis of the external oblique.

The wound is closed in the usual manner, and if the subcutaneous tissues have been contaminated by the fluid contained in the hernial sac it is a wise precaution to insert a small drain through the lower part of the incision.

3. Strangulated Umbilical Hernia. As the skin over the swelling or in one of the folds may be eczematous or inflamed, some minutes

must be spent in cleansing the area with ether and alcohol before the patient is removed to the operating room. Before the incision is made, the umbilical swelling and the parts around are again lavishly painted with alcohol or mercurochrome. Severe infection of the wound or cellulitis of the abdominal wall is a grave and not infrequent complication following operation for strangulated umbilical hernia.

A curved incision is made round the lower part of the neck, where the coverings are thicker and where the contents are least likely to be adherent to the sac. The fibrous ring, the neck of the sac, and the adjacent aponeurosis must be freely exposed before the peritoneum is incised and the sac slit up toward the fundus. After this the constriction is cut laterally and the ring is firmly stretched with the fingers.

The contents are now scrutinised, and adherent intestine is separated from the sac and omentum and reduced into the abdominal cavity. The omentum is ligatured off bit by bit on a level with the neck of the sac and cut across there, any adhesions to the sac being left undisturbed.

The whole mass—sac, adherent omentum, fat and skin—is now removed by making another curved incision which passes over the superior aspect of the neck and joins the previous incision round its lower aspect.

The operation is completed by performing Mayo's operation (see page 1007).

THE TREATMENT OF DOUBTFUL AND NON-VIABLE INTESTINE

1. **Doubtful Intestine.** It is impossible to lay down any definite rules with regard to the treatment of doubtful intestine as so much depends upon the condition of the patient, the degree of damage to the intestine, and the experience of the surgeon. A small patch of gangrene on the anti-mesenteric border of the apex of the bowel can be safely turned in and the necrosed ring-like area of constriction invaginated by a Summers' suture (*Ann. Surg.*, 72:20, 1920) or a continuous Lembert suture, provided the lumen is not unduly narrowed by this stitch and the rest of the loop is healthy. But if the constricted part is severely damaged or if the recovery of the strangu-

lated loop is in question, the only safe course is to regard the gut as being non-viable.

2. *Non-viable Intestine.* The treatment of the strangulated large intestine is stereotyped. The surgeon must not, under any circumstances, resect the gangrenous loop and then proceed with a primary anastomosis and "drop" the anastomosed portion into the peritoneal cavity. To do this is to court disaster. The lifeless loop should be exteriorised and drained—colostomy, or resected, in which case both ends of the gut must be drained as in the Mikulicz or Devine type of operation.

If a loop colostomy has been performed, a secondary operation for closure of the faecal fistula will be required later on when the patient has completely recovered. In the Mikulicz or Devine type of colostomy the spur should be crushed with an enterotome as soon as the patient is out of danger, the colonic stoma being closed extraperitoneally about two months later. Where only a small area of the colon is involved, the simple procedure of inverting the gangrenous patch with one or more purse-string sutures will, of course, prove to be adequate.

The operative measures which may be required in the treatment of gangrenous or non-viable *small intestine* include:

1. *Immediate Resection and Anastomosis.* The anastomosis may be: (a) end-to-end; (b) side-to-side; (c) end-to-side.

2. *Pauchet's Method* (*Pratique chir.* Illus., Fasc., 13:232, 1929).

3. *Exteriorisation.* (a) Simple exteriorisation; (b) exteriorisation plus drainage of the proximal portion of intestine; (c) exteriorisation, intraperitoneal lateral entero-anastomosis, proximal Witzel enterostomy followed by resection of the exteriorised loop, drainage of each open end, and intraperitoneal closure of the ends of the intestine.

IMMEDIATE RESECTION AND ANASTOMOSIS

This procedure has a mortality of about 45 per cent. It possesses three advantages over exteriorisation:

1. The patient does not lose ground through non-absorption of nourishment.

2. It is free from the danger of a sloughing and spreading cellulitis

of the abdominal wall owing to autodigestion by the escaping digestive juices.

3. It avoids the subsequent task of closing an intestinal fistula.

For these reasons immediate resection plus anastomosis should be chosen in all cases in which there is a good chance of survival, *i.e.*, with early strangulation of a small loop if the patient is in good or moderately good condition.

Cokkinis writes:

It is impossible to fix a time limit, and there are bound to be borderline cases, but the procedure is particularly desirable in *young children*, who rarely tolerate an intestinal fistula, and in *jejunal strangulation*, where a high fistula is very apt to lead to severe auto-digestion and rapid starvation. The condition of the intestine *above* the strangulation may also influence our choice; the healthier it is, the better are the prospects of immediate resection. The *length* of the segment to be resected may be an important factor in large inguinal or umbilical herniæ, enormous lengths of intestine have been removed with little or no harmful consequences, but as a rule the shorter the necrosed segment the better is the chance of survival. Not infrequently the *experience* of the operator should be the deciding factor; whilst a skilled surgeon may be justified in taking the immediate risk of a primary resection, the occasional operator will be well advised to choose the simpler and, in his hands, less dangerous procedure of exteriorisation, unless the circumstances are exceptionally favourable for the more radical measure.¹

The first step in the operation of enterectomy and entero-anastomosis is the careful inspection of the mesentery of the necrosed loop and of the more grossly damaged proximal intestine to determine the extent of the resection. The parts engaged in the anastomosis must be healthy and they must have a good blood supply. In practice this means that the necrosed coil of gut, together with at least 6 inches of the intestines distal to it, 2 feet of the gut proximal to it, and a corresponding portion of the mesentery, is resected.

Most fatalities can be attributed to peritonitis due to leakage at the suture line, to perforation, or to paralysis of the proximal intestine. The proximal intestine is always distended, and its blood supply is interfered with, particularly in the last one or two feet above the lifeless loop. It may also show patches of distension necrosis along its anti-mesenteric border, which are a source of danger.

¹ Cokkinis *Post Graduate Surgery*, Medical Publications, London, vol. 1. p. 1057. 1955.

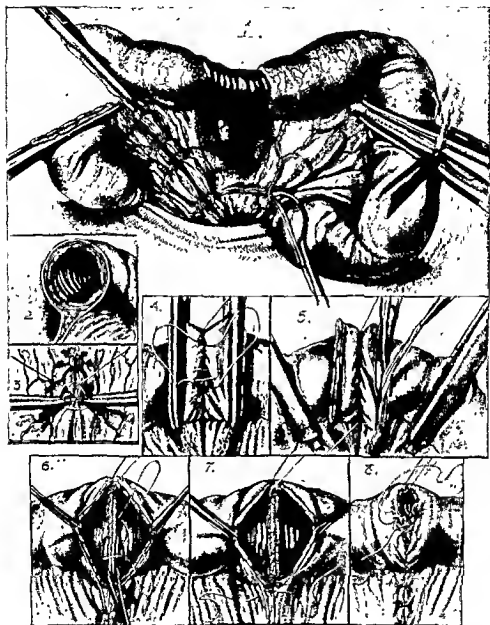


FIG. 224.—RESECTION OF THE INTESTINE AND END-TO-END ANASTOMOSIS.

The surgeon should make it a rule to resect a little more than is necessary under the circumstances. There are many methods of restoring the continuity of the small intestine, but I prefer the simple and well-tried technique of end-to-end anastomosis or side-to-side anastomosis by open suture. End-to-end anastomosis gives a good

anatomical result, and should be the method of choice when the calibre of the two loops is much about the same. When, however, the proximal end is markedly distended and the distal end is narrow and contracted, lateral anastomosis is a safer undertaking.

The Technique of Resection and End-to-End Anastomosis. The portion of the intestine about to be resected is lifted upward to render the blood vessels in the selected portion of the mesentery visible. The blood vessels are underrun with an aneurysm needle and tied off in two places so as to render the division of the V-shaped portion of mesentery a bloodless affair (fig. 224 [1]). The mesentery is divided between ligatures up to a healthy portion of intestine on each side of the part to be resected, after which the gut at the proposed lines of section is carefully examined and if found to be viable the crushing clamps are applied.

Any large, strong, straight or slightly curved hæmostat, *e.g.*, Kocher, Ochsner, Parker-Kerr, etc., may be used as an enterotome. Figure 224 (1) illustrates the importance of applying the crushing clamp obliquely to the intestine so that more of the anti-mesenteric area is removed. This ensures a good blood supply to the cut end of the intestine and at the same time considerably increases the diameter of the intestine, thereby overcoming any tendency to stricture formation at the site of the anastomosis.

It should be noted that the clamps are so placed that their tips barely project beyond the bowel on the mesenteric side, and that the gut is divided with the cautery, diathermy blade, or carbolised knife in order to arrest bleeding and to ensure aseptic edges for the anastomosis.

After the intestine has been cut across between the clamps on both sides, the affected segment of gut together with its attached mesentery is lifted away intact. If the blood vessels in the mesentery are ligatured and divided as depicted and the proximal and distal intestine is transected in the manner described, there will be no bleeding, no peritoneal soiling and no shock.

The so-called "danger area"—the little Δ at the junction of the intestine and its mesentery—may be crushed with the points of artery forceps and ligatured off as advised by Horsley (*Operative Surgery*, 1937), but in practice I have not found it a serious problem (fig. 224 [2]). The two crushing clamps are next brought together and the

end-to-end anastomosis is carried out in three layers as illustrated in the accompanying figure.

The clamps which were placed side by side and parallel with one another are now slightly rotated externally so as to bring into view the adjacent posterior aspects of the proximal and distal ends of the intestine. The first posterior layer consists of a number of interrupted seromuscular sutures of fine silk introduced on a small round-bodied eyeless needle. This row of sutures is inserted about a $\frac{1}{2}$ inch from the medial sides of the crushing clamps. The second posterior suture is a continuous seromuscular Cushing stitch of No. 00 twenty-day chromic catgut. It is introduced just distal to the row of interrupted silk sutures, and starts at the anti-mesenteric border. When this stitch reaches the mesenteric border it is locked once or twice and the needle is laid aside.

A pair of rubber-covered intestinal clamps is now placed on each side of the junction at a distance of 3 inches from the crushing clamps. The crushing clamps are removed, the intestinal clamps are tightened, the crushed ends of the intestines are trimmed away with scissors, and both ends of the bowel are opened up, emptied, and thoroughly swabbed with warm saline solution.

The third posterior suture is introduced as a continuous through-and-through all-coats hæmostatic suture or, as I prefer, as a continuous lock-stitch. It commences at the anti-mesenteric border and finishes at the mesenteric border where it is locked. This stitch now turns the corner and is continued as the first anterior row of sutures. At the mesenteric border it is passed as a loop-on-the-mucosa or Connell stitch, effectively dealing with the "danger area," and after approximating and invaginating the anterior margins of the intestine it is tied to the end which was left long at the anti-mesenteric border when it reaches this point.

The second posterior suture is now picked up and continued anteriorly as a continuous Cushing stitch. It turns in the Connell suture, and its end is knotted at the anti-mesenteric border of the bowel. The anastomosis is completed by inserting a few interrupted sutures of fine silk here and there on the anterior line of the anastomosis.

The cut edges of the mesentery are now brought together with a series of interrupted stitches by means of a continuous suture of

catgut, great care being taken to avoid puncturing or strangling the blood vessels in the vicinity. Figure 224 (3) shows a simple, quick and effective method of closing the gap in the mesentery.

The suture line in the intestine and mesentery is next washed in saline solution, and omentum is drawn across the sutured area for added protection. Drainage of the peritoneal cavity is as a rule not required.

The Technique of Resection and Side-to-Side Anastomosis. The method of resecting the intestine together with its mesentery is similar to that just described.

The proximal and distal ends of the intestine must be securely closed and invaginated before proceeding with the lateral anastomosis. Many methods of inverting the cut ends of the gut are available, but they are all identical with those already described and illustrated in detail previously. The Mikulicz stitch effects a rapid and satisfactory closure. A No. 0 or No. 00 twenty-day chromic catgut suture on a curved eyeless needle is started on the anti-mesenteric border of the gut and is continued to and fro across the crushing clamp. When the mesenteric border is reached, the clamp is released and, as it slides out, each end of the stitch is pulled upon firmly. The edges of the gut are neatly infolded, and the return seromuscular Lembert suture completes the closure. The suture line is then further reinforced with a series of closely-applied interrupted sutures of fine silk.

The proximal and distal limbs of intestine are now placed side by side (for a distance of 5 to 6 inches) and in such a way as to make an iso-peristaltic junction (fig. 225). The portions of the intestine which are to be engaged in the anastomosis are milked free of bowel contents, after which they are clamped in the manner depicted in figure 225.

The first posterior layer consists of a series of interrupted sutures of fine silk, and the second posterior layer of No. 0 or No. 00 twenty-day chromic catgut is inserted as a Cushing right-angled suture. The adjacent pouches are now opened with the cautery on either side of the Cushing stitch for a distance of 2 to 3 inches, and the interior of the gut is cleansed. Owing to the close proximity of the invaginated stumps, the anastomotic opening must be not less than 2 inches in length.

The third posterior suture of No. 0 or No. 00 twenty-day chromic catgut is introduced on an atraumatic needle as a continuous through-and-through all-coats hæmostatic suture or as a continuous lock-stitch. This suture is continued anteriorly as a Connell stitch, the second posterior suture is carried anteriorly as a Cushing stitch, and the anterior suture line is finally reinforced with a series of interrupted sutures of fine silk.

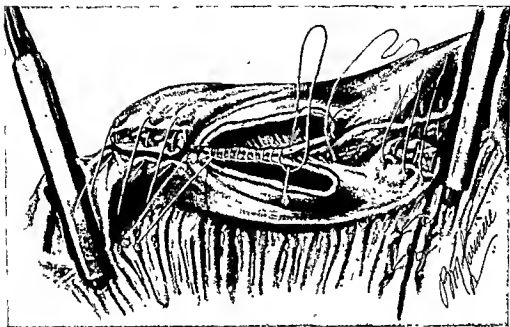


FIG. 225.—ENTERO-ANASTOMOSIS, SIDE-TO-SIDE METHOD.

The stumps are now fixed with three or four interrupted sutures to the adjacent limbs of the anastomosis and turned in against the intestine (see fig. 225). This step safeguards the patient against the very real danger of bursting or leakage of the stumps, especially the proximal stump.

SHOULD AN ENTEROSTOMY BE PERFORMED AT THE COMPLETION OF THE OPERATION?

An enterostomy is *unnecessary* if the gut above the anastomosis is not markedly distended and if it is seen to be undergoing peristalsis or is judged to be capable of looking after itself. If there is any post-

operative distension, a duodenal tube, or better still a Miller-Abbott tube, can be passed to ensure adequate decompression.

An enterostomy is *desirable* if at the completion of the anastomosis the proximal coils of intestine remain grossly distended and immobile. In such cases the bowel should be drained by a Witzel enterostomy (or by Wangenstein's modification of Witzel's method) a foot or so above the anastomosis, the catheter being led out through a small stab incision a few inches away from the main wound (fig. 226). There are a number of surgeons, on the other hand, who consider that the enterostomy is an unnecessary refinement, as drainage of the proximal intestine can be achieved satisfactorily by an indwelling duodenal or Miller-Abbott tube.

Should the resection and the anastomosis be performed outside the hernial orifice and the intestine then be dropped back into the abdomen, or should the abdomen be opened by a separate incision and the damaged bowel be withdrawn through this wound for the resection and anastomosis? I prefer the former course. It is obviously a safer procedure and it avoids the danger of soiling of the peritoneum.

If the hernial orifice is slightly enlarged and if the inguinal route is employed in femoral strangulations, the intestine can be drawn downward for resection and returned to the abdomen on completion of the anastomosis without any danger of trauma.

At the completion of the resection and entero-anastomosis, should a radical cure of the hernia be performed? A radical cure should *not* be attempted if:

1. The patient is in poor condition.
2. Peritonitis is present or there has been pre-operative rupture of the intestine.
3. There is gross contamination of the wound during the operation, or the muscular and aponeurotic layers of the inguinal canal are sodden with inflammatory œdema.
4. In order to effect a satisfactory repair a major undertaking such as Gallie's operation is indicated.

In all cases the hernial sac should be excised. Where peritonitis is present it is better to drain through a suprapubic stab wound than through the open neck of the sac. When immediate radical cure is

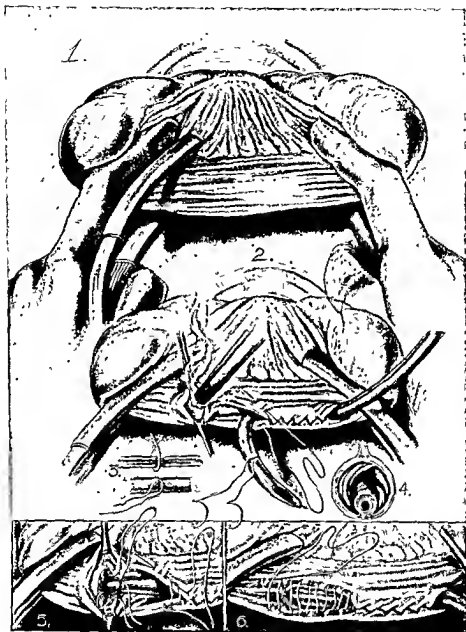


FIG. 226.—WANGENSTEEN'S MODIFICATION OF WITZEL'S ENTEROSTOMY.

contra-indicated, the wound should be lightly closed and freely drained. Some weeks later when the wound has soundly healed and there are no signs of any residual inflammation, a well-planned operation for the radical cure of the hernia can be carried out without any danger.

PAUCHET'S OPERATION

I have performed this operation, or rather a slight modification of it, in three cases with success.

The gangrenous coil, a foot or two of the intestine proximal to it, and at least 6 inches of the intestine distal to it, together with the involved mesentery, are resected in the manner already described (see page 1034). The ends of the proximal and distal intestine are securely closed and invaginated.

A lateral iso-peristaltic anastomosis is then effected about 8 inches proximal to the inturned stump of the proximal intestine. The long free limb of the proximal intestine beyond the anastomosis is then brought through a small stab wound on to the surface of the abdomen; it is anchored to the parietal peritoneum by a stitch which catches the free edge of its mesentery close to the anastomosis; the closed end is picked up in Allis forceps and amputated; a wide-bore rubber tube, some 20 inches long, is passed through the exteriorised limb of the intestine and then beyond the anastomotic stoma for a distance of 3 to 4 inches; the last inch of the gut is closed lightly around the tube with an encircling ligature of tape; the end of the tube is clamped with a hæmostat or closed with a wooden spigot; and the main incision is then sutured. The long rubber tube is connected to a bottle at the side of the patient's bed and freely drains the distended proximal intestine. If it acts too freely and the patient shows signs of dehydration, the tube may be clamped for long periods.

At the end of four to five days, the tape ligature cuts through the walls of the intestine, and to prevent spillage a portion of the intestine a little higher up should then be tied to the tube. By the end of the second post-operative week the patient should be well on the way to recovery, and by that time the enterostomy no longer serves any useful purpose; in fact it becomes a source of annoyance.

At a secondary operation the small stump of exteriorised intestine which remains is dissected free from the layers of the abdominal wall and cut away, after which the gap in the bowel is closed with a Connell suture which is adequately reinforced with interrupted silk sutures.

THE TECHNIQUE OF EXTERIORISATION

Method 1. The loop of gut is brought out through the wound and left on the abdominal wall where it can be inspected at frequent intervals. A glass rod is passed through the mesentery to prevent the gut from slipping back into the abdominal cavity. When its viability is certain, it is returned to the abdomen and the incision is closed. When the coil is greatly distended, it may be drained by a self-retaining catheter.

If it is obvious that the exteriorised loop is necrotic, it should be excised and a tube fixed into each open end. After an interval of four to eight days, varying with the condition of the patient and the level of the strangulation, the operation is completed by closing the faecal fistula and re-establishing the continuity of the intestine by a side-to-side anastomosis.

Method 2. The strangulated coil, with at least 24 inches of proximal and 6 inches of distal intestine, is brought out of the wound. A lateral anastomosis is established as far as possible from the necrosed segment of bowel, and the anastomosed portion is returned into the abdomen.

A Witzel enterostomy is then made 12 inches proximal to the anastomosis, the catheter being brought out through a separate stab wound. The strangulated coil, with a margin of viable gut at each end, is fixed outside the wound by a glass rod passed through its mesentery and the wound is closed as snugly as possible round its base. If it is very much distended, a self-retaining catheter may be inserted into it for drainage purposes.

After twenty-four to forty-eight hours the exteriorised loop is resected and a tube is tied into each open end. These two tubes may be connected up by means of a glass cannula so that the intestinal contents escaping from the proximal end pour into the distal end, thus maintaining the nutrition of the patient. The tubes work loose about the fifth day, and the fistulae should then be closed. By the fifth day, however, the patient and the intestine should have recovered sufficiently to make the closure perfectly safe, particularly if the proximal enterostomy or the Miller-Abbott tube is still functioning. Both open ends of the intestine are dissected free, amputated, closed.

invaginated and then they are dropped back into the peritoneal cavity.

Exteriorisation procedures are rapidly gaining in popularity owing to the forceful teaching of Wangensteen (*Arch. Surg.* 26:933, 1933; and *Bowel Obstructions*, 1936), Elman (*Surg., Gynec. & Obst.*, 56:175, 1933) and other surgeons, and to the fact that they are relatively easy to perform and are associated with a lower primary mortality than the more radical method of immediate resection and anastomosis.

But there are disadvantages, some of which are indeed formidable. The external intestinal fistula may at times be difficult to control; it may be uncontrollable; it may lead to marked dehydration and inanition; it may produce widespread excoriation, cellulitis and sloughing of the abdominal wall; it may make the second-stage operation of entero-anastomosis so hazardous that it becomes the desperate measure of a desperate surgeon.

Most of the unpleasant sequelæ in abdominal surgery can, nevertheless, be overcome with care, patience, thoughtful planning, craftsmanship and ingenuity. We are rapidly learning the indications for exteriorisation operations, how to prevent the unpleasant consequences of an external intestinal fistula, how to restore the continuity of the intestinal canal in the face of obstacles, and, above all, how to save lives in cases of strangulation.

PART X

INTESTINES

CHAPTER 1

INJURIES OF THE INTESTINES

Injuries of the intestines may, for convenience, be divided into two main groups:

1. Subcutaneous or non-penetrating injuries.
2. Percutaneous or penetrating injuries.

SUBCUTANEOUS INJURIES

Subcutaneous, sub-parietal, closed or non-penetrating injuries of the intestines are of major surgical importance and are daily becoming more frequent owing to warfare, automobile and aeroplane crashes, dangerous occupations, *e.g.*, in factories, active sports, etc. According to Geill (quoted by Vance: *Arch. Surg.*, 16:630, 1928), subcutaneous injuries involve the abdominal viscera in the following order of frequency: liver, spleen, kidneys, intestines, stomach, bladder and pancreas. The intestines were involved in 11.1 per cent of his cases.

Contusion or rupture of the intestine may be due to:

1. Direct violence;
2. Indirect violence; or
3. Muscular action.

The majority of intestinal injuries are, of course, occasioned by direct violence, which may be sub-divided into generalised or localised trauma.

Moty described three modes of rupture due to direct violence:

1. By *Crushing*. Here the intestine is squeezed against the unyielding spine or sacral promontory and the direct force is applied perpendicularly to the abdomen.
2. By *Tearing*. Here the force is applied tangentially to the abdominal wall, causing the bowel to be torn from its attachments.

3. *By Compression.* Here the abdomen is violently compressed and the gut, as it were, explodes through increased abdominal pressure exerted by fluid or gas trapped in the bowel between the angulations of the wall.

The commonest causes of visceral injuries have already been outlined, but today we have also to take into account the havoc wrought by aerial bombardment and by shelling—falling masonry and flying fragments or masses of wood, stone, concrete or metal, etc. Visceral damage may even be produced as the result of an explosion—blast, without any visible external sign of injury.

Rupture of the intestine or of its mesentery may occur by indirect violence where, for instance, an individual falls, landing on his feet or on his buttocks with the body in an upright position, so that the sudden jolt causes the intestines by their weight to tear away from their mesenteric attachment.

Wilensky and Kaufman (*Ann. Surg.*, 106:373, 1937) cited cases in which intestinal rupture was caused by muscular effort alone, e.g., by lifting heavy weights. These authors also call attention to the fact that those who have a large or irreducible external abdominal hernia are particularly prone to intestinal rupture as the result of contusion of the abdomen. Aird (*Brit. J. Surg.*, 24:529, 1937) states that rupture may be due to violence applied directly to the hernia, to direct abdominal injury, or rarely to a sudden hyperextension of the trunk.

If the large series of Makins (*Ann. Surg.*, 30:137, 1899), Berry and Giuseppi (*Proc. Roy. Soc. Med.*, 2:1, 1909), Cope (*Proc. Roy. Soc. Med.*, 7:86, 1914), Battle (*Lancet*, 2:103, 1919) and Rowlands (*Brit. M. J.*, 1:716, 1923) be examined, it will be seen that the small intestine was the site of rupture in some 90 per cent of the cases, the jejunum and the ileum being involved about equally, and that the stomach, duodenum and colon were involved in approximately 10 per cent. Much credit is due to these British surgeons for their pioneer work in this field of surgery. Grant Massie (*Lancet*, 2:640, 1923) in a study of 34 cases noted that the beginning of the jejunum (the first three feet) and the end of the ileum (the region of the ileo-cæcal attachment) were by far the most frequent sites of traumatic perforation. Counseller and McCormack (*Ann. Surg.*, 102:365, 1935) believed this to be attributable to the limited mobility of these sections of the intestines and their proximity to fixed bony structures.

TABLE I

SITUATION OF SUBCUTANEOUS RUPTURES OF THE INTESTINES

Authors	Duo- denum	Jeju- num	Ileum	Small intestine*	Colon	Not stated	Total
Battle (St. Thomas' Hosp.)	32	111	59	2	11	7	222
Berry and Giuseppi (Royal Free Hosp.)	26	32	32	25	10	7	132
Rowlands (Guy's Hosp.)	23	157	158	0	43	0	381
TOTALS	81	300	249	27	64	14	735

* Situation of rupture not more accurately given

While intestinal injuries generally result from the more severe forms of violence, it should nevertheless be remembered that visceral rupture may be caused by apparently trivial blows on the abdomen. When visceral lesions are present, abrasions or contusions of the skin are rare, and actual tearing of the abdominal muscles is an even more unusual event. A violent blow which ruptures a strong muscle of the abdominal wall is frequently too spent to damage the intestines. Contusions of the intestinal wall may be single or multiple, and "although in slight cases spontaneous cure may result, more serious damage to the tissues of the gut wall may determine subsequent intestinal perforation from the separation of a gangrenous patch, the development of ulcers of the mucous membrane, or the late advent of obstruction of the bowel."¹

Rupture of the bowel may be incomplete or complete.

In the former, one or more coats are torn, but the lumen of the intestine does not communicate with the peritoneal cavity. Complete ruptures may be single or multiple; again, they may be uncomplicated or be associated with multiple visceral or parietal lesions. The perforation in the gut may be very small, not exceeding two or three millimetres in diameter; it may be large enough to admit the tip

¹ Gordon-Taylor, *The Abdominal Injuries of Warfare*, 1939.

of the finger; it may be a longitudinal or transverse linear tear situated either at the anti-mesenteric or the mesenteric border of the bowel; it may be sub-total; or it may be total—transecting the intestine. The edges of the rupture may appear healthy, or they may be contused, œdematous and suffused with blood, the pouting everted mucous membrane being Nature's provision for corking the hole. Fraser and Drummond (*Brit. M. J.*, 1:321, 1917) point out that very little leakage of intestinal contents occurs during the first six hours following perforation, as at this stage peristaltic movements are inhibited and the everted congested mucous membrane acts as an efficient plug, a fact to which Jobert de Lamballe first drew attention. Even in total ruptures, spillage does not occur during the early hours because of the tight contraction of the circular muscle coat in the severed ends.

The mesentery of the small intestine, the great omentum, the gastro-splenic omentum or the mesocolon may be bruised, lacerated or detached in some 30 to 40 per cent of the cases of intestinal injury. The mesentery of the jejunum-ileum may be torn transversely, vertically or radially. Mesenteric tears parallel to the gut may be found either at a distance from the bowel or close to the intestinal attachment of the membrane—"mesenteric disinsertion." Vertical tears are the least dangerous; radial tears, although at times quite localised, may extend fanwise from the margin of the intestine to the base of the mesenteric attachment and be associated with profuse bleeding.

DIAGNOSIS

The early diagnosis of intestinal injuries due to non-penetrating wounds is always difficult—doubt; the late diagnosis is easy—peritonitis or hæmorrhage. Every effort must be made to arrive at a diagnosis during the first three or four hours following the receipt of the injury, and the surgeon should bear in mind that every injury to the parietes, however trivial, may be accompanied by serious lesions of the viscera and that the abdominal organs—and more especially the small intestines, may be ruptured without any visible signs of trauma to the abdominal wall. He should make a point of regarding every case of abdominal contusion when first seen as a case of *possible* severe intestinal injury.

The diagnosis is made by taking a careful history of the accident, by noting how the blow was inflicted and what part of the abdomen was struck, by a methodical physical examination of the patient, and by a consideration of the clinical picture as a whole. No one sign or symptom is pathognomonic of intestinal rupture. In doubtful cases the patient should be kept under close observation for a few hours, during which time a record is kept of the temperature, the pulse-rate, the respiration-rate and the blood pressure, and if, say at the end of four hours, there is still an element of doubt, it is wiser to explore the abdomen than to procrastinate. Most of the deaths from traumatic rupture of the intestine are due to delayed operation. In the cases which are seen early, shock or the "shock-hæmorrhage" syndrome often obscures the diagnosis. In the cases which are seen late, the picture is that of severe hæmorrhage or of a spreading peritonitis.

Analysis of the Symptoms and Signs.—1. *Shock.* Most of the patients are admitted to hospital in a condition of primary shock, and the pallor, the cold clammy extremities, the feeble pulse, the shallow respirations and the low blood pressure all proclaim the state of affairs present. Shock may be immediate or delayed. After a variable period there is recovery from the shock, and the patient may appear to be making satisfactory progress. But if in spite of treatment the symptoms do not pass off within six hours, hæmorrhage or peritonitis is almost certainly an additional factor.

2. *Hæmorrhage.* With internal hæmorrhage there is marked abdominal pain, increasing restlessness, rising pulse-rate, progressive pallor of the lips, slight tenderness and rigidity of the abdomen, shifting dulness in the flanks, etc.

3. *Pain.* This is acute from the start. It is constant, not colicky, and increases in severity as time passes. At first it is more or less diffuse; then it localises to one area, finally becoming diffuse once more. It is the most reliable symptom in diagnosis.

4. *Nausea and Vomiting.* Vomiting when present is significant, and more particularly when it is repeated or continuous. If the patient has recovered from shock, incessant vomiting is suggestive of intestinal perforation.

5. *Tenderness and Rigidity.* In the early stages, tenderness and

rigidity may be diffuse or localised. If diffuse, there will frequently be a localised area of maximum intensity over the site of the injury. Muscular rigidity is a most constant and valuable sign. An absence of guarding may, however, be observed in those cases of contusion of the bowel without primary rupture or hæmorrhage, occasionally in cases with a marked degree of shock, and very rarely in late cases with generalised peritonitis associated with profound toxæmia in which meteorism predominates.

A digital rectal examination should be conducted in all cases, as tenderness of the pelvic peritoneum will be elicited when peritonitis is present, and also when the pelvis is contaminated with escaping intestinal contents and even with fresh blood. Rupture of the intestine is the commonest cause of peritonitis after an abdominal injury has been suffered.

6. *Shifting Dulness in the Flanks.* This, when present, is an unequivocal sign of intra-peritoneal injury, and calls for immediate operation. In the early case, shifting dulness in the flanks is pathognomonic of severe hæmorrhage; in the late cases it may be caused by large collections of peritoneal exudate.

7. *Abdominal Distension.* This occurs late and accompanies the development of peritonitis.

8. *Liver Dulness.* Diminution or obliteration of hepatic dulness is not an early sign of perforation of a hollow viscus, but rather a late manifestation of acute generalised peritonitis with distension of the intestines, and more especially the colon.

9. *Emphysema of the Abdominal Wall.* This may be noted in certain cases of retroperitoneal rupture of the duodenum or of the colon.

10. *Auscultation.* The abdomen is "silent"; in other words there are no peristaltic sounds to be heard following the perforation of a hollow viscus. This statement, however, must be guarded, since in some of the more limited perforations feeble sounds may on occasion be transmitted.

11. *Claybrook's Sign.* Totten writes as follows concerning this sign:

The transmission of the heart and respiratory sounds so that they can be heard almost as well all over the abdomen as over the chest was first described

by G. A. Peters, of Toronto, in a paper entitled "The Telephonic Properties of the Inflamed Abdomen" in the *Canadian Journal of Medicine and Surgery*, December 1902. It was reported again by Claybrook (*Surg., Gynec. & Obst.*, 18:105, 1914) in 1904. The latter author considered it a positive indication for laparotomy whether other signs are present or not and believed it due to irritation of the parietal peritoneum by the sudden outpouring of foreign material into the abdominal cavity. He noted the sign in cases of ruptured solid viscus with hæmorrhage as well as in cases of ruptured hollow viscus with free air.

Ledgard (*Indian M. Gaz.*, 69 507, 1934) believed the phenomenon was due to gas in the peritoneal cavity, as he did not think that the presence of free fluid alone was enough to produce the sign. I, however, have observed the sign in a case of ruptured, as well as hollow viscus, but I am not prepared to venture an opinion as to its value as a frequent diagnostic sign.¹

12. *Blood Count.* In cases of intestinal perforation there is often a moderate leucocytosis.

13. *X-Ray Examination.* In many instances the presence of free gas, intestinal contents, and even blood, may be demonstrated in straight X-ray films. The crescent of gas between the upper surface of the liver and the diaphragm can be made out in a number of cases of ruptured intestine, and when present in suspected cases of intestinal injury it is sufficient evidence to warrant exploration (fig. 227). Negative X-ray findings should not influence the surgeon's decision.

14. *Temperature, Pulse-Rate, Respiration-Rate and Blood Pressure.* During the observation period these should be recorded every fifteen minutes. They are all, of course, lowered when shock is present, while on recovery from shock they show a gradual return to normal. Following the recovery period, a steadily rising pulse-rate with a falling blood pressure is indicative of an internal hæmorrhage. A progressive rise in the temperature and in the pulse-rate, especially if associated with abdominal pain and rigidity, denotes spreading peritonitis.

Cope (1935) insists that injuries of the spine, kidneys and thorax must first be excluded, but suspects rupture of the intestine:

1. When abdominal pain persists for more than six hours after the receipt of an injury and is accompanied by: (a) vomiting; (b) a

¹ Totten, *Surg.*, 4:397, 1939. Courtesy of C. V. Mosby Co.



FIG. 227 —A STRAIGHT X-RAY PICTURE SHOWING A CRESCENT OF GAS BENEATH THE RIGHT CUPOLA OF THE DIAPHRAGM IN A PATIENT WHO HAD SUSTAINED A RUPTURE OF THE PROXIMAL JEJUNUM DUE TO A NON-PENETRATING INJURY OF THE ABDOMEN. (Derry.)

gradually rising pulse-rate; (c) local rigidity which tends to spread, and (d) deep local tenderness with shallow respiration; and

2. When abdominal pain is absent or very slight, but the pulse-rate rises steadily and the patient is listless or restless.

PROGNOSIS

The prognosis in cases of ruptured intestine is bad unless a diagnosis is made and operation carried out soon after the injury. The

importance of making an early diagnosis and operating promptly is seen from the much quoted figures presented by Siegel (*Beitr. z. klin. Chir.*, 21:395, 1898), who studied the records of 376 cases in which operation was performed, and showed that the mortality increased as the time between the injury and operation increased.

TABLE 2

MORTALITY IN RELATION TO INTERVAL BETWEEN INJURY
AND OPERATION

(Siegel)

THE TIME FACTOR IN PROGNOSIS

<i>Time of Operation in Relation to Time of Injury</i>	<i>Mortality %</i>
Within the first 4 hours	15.2
From 5 to 8 hours	44.4
From 9 to 12 hours	63.0
After 12 hours	70.0

Counseller and McCormack (1935), in an analysis of the records of 1313 cases of subcutaneous rupture of the intestines of patients of all ages, found the total mortality to be 73 per cent, but if the cases not operated upon are excluded the death-rate is about 60 per cent.

According to Lockwood (*Internat. J. Med. & Surg.*, 47:35, 1934), the best results follow when operation is performed between two and four hours after injury, the mortality increasing approximately 15 per cent with every succeeding four hours. While therefore the time-factor has an important bearing upon the death-rate, the following points should also be taken into consideration:

1. The nature of the traumatising force.
2. The position of the intestinal rupture.
3. The presence of associated intraperitoneal injuries, *e.g.*, ruptured mesentery, liver, etc.
4. The presence of associated extraperitoneal injuries, *e.g.*, ruptured bladder, kidneys, etc.
5. The skill and judgment exercised by the surgeon in the management of the case.

TREATMENT

When the patient is admitted to hospital he will often be in a state of shock, and if this is so the usual anti-shock remedies should be applied for an hour or so before proceeding with operation; but if shock is absent or slight and the signs point to the presence of a major abdominal catastrophe, no useful purpose will be served by thus delaying surgical treatment.

The pre-operative treatment may be summed up in a few words: morphia, heat to the body, and the transfusion of blood. Blood and a glucose-saline solution are given by the slow-drip method as a routine measure. The intravenous administration of gum acacia (6 per cent) is, according to Studdiford, a dangerous substitute for blood and, in my opinion, it should never be given owing to its toxic effect upon the liver cells and red blood corpuscles.

The abdomen is best explored through a long right paramedian, para-umbilical incision, as this is capable of being readily extended upward or downward without damage to the abdominal wall, according to the individual requirements of the case.

The operation must be conducted expeditiously and with a minimum of shock to the patient and trauma to the tissues. If on opening the peritoneum active bleeding is observed, the surgeon should examine the viscera in the following order: the liver, spleen, stomach, duodenum, duodeno-jejunal flexure, pancreas, omenta, the intestines and their mesenteries, and finally the pelvic organs. After bleeding has been controlled, a rapid search is made for concomitant visceral lesions. Tears of the mesentery are often associated with profuse hæmorrhage, and after the bleeding points have been ligatured the related portion of the intestine should be carefully scrutinised for any alteration in colour. If after dealing with a tear in the mesentery an adjacent portion of bowel takes on a mauve tint, becomes dark brown in colour, or in fact shows any appreciable deviation from the healthy hue, it is best to assume that the involved segment is lifeless. Vertical lacerations of the mesentery often lend themselves to suture, but transverse tears, especially those which are more than one inch in length, frequently call for excision of the gut.

If there is no hæmorrhage, the bowel and the mesentery should

be closely examined, starting at some fixed point such as the duodeno-jejunal flexure or the ileocaecal region, drawing out a few inches of the bowel at a time and following up and down the entire intestinal tract. The surgeon must inspect the small intestine once, and once only; there must be no re-examination as this would tend to augment shock. He should withdraw each loop in an orderly fashion, examine it and then replace it in the abdomen. If, however, a perforation or contusion of the bowel is found, the affected portion of gut should be covered with a warm moist swab and laid aside until the whole intestine has been inspected. The colon is next investigated. All retroperitoneal hæmatomata should be explored lest an extraperitoneal perforation be missed. Small perforations on the anti-mesenteric border can be rapidly closed with purse-string sutures of fine silk reinforced with interrupted Halsted stitches and omental pads. Clean-cut anterior, longitudinal or transverse tears are quickly and efficiently sutured with a Connell loop-on-the-mucosa stitch, after which the suture line is turned in with a series of Lembert or Halsted sutures. Complete rupture of the small intestine demands end-to-end or side-to-side anastomosis.

Resection is indicated:

1. When a coil of intestine is lifeless, pulped or severely contused
2. When multiple perforations are found close to one another.
3. In those cases where the gut has ruptured between the leaves of the mesentery.
4. In some cases where the gut wall surrounding a large perforation is markedly congested and œdematous.
5. In certain cases of incomplete rupture of the intestine.
6. In cases of mesenteric or intestinal infarction.
7. When the mesentery has become detached from the intestine for more than one inch.
8. In all cases of tears of the mesentery associated with discolouration of the related portion of the gut.
9. In some contusions of the mesenteric border of the bowel where vascular damage or extravasation of blood occasions anxiety as to the success of suture.
10. In some injuries of the large bowel (see page 1058).

PENETRATING INJURIES

The diagnosis of intestinal injury due to a penetrating wound is usually simple and the indications for surgical treatment are often unquestionable. Gordon-Taylor maintains that "whatever the traumatic agency—laceration by spike or stake, a stab with a knife, dirk or dagger, bayonet thrust, or the more frequent gunshot wound or bullet, shell or bomb—the general principles of treatment are alike. A penetrating wound in the abdomen probably means a penetrating wound of the bowel or other abdominal viscus, and demands the earliest surgical intervention, unless a wisdom of prescience born of great experience justifies restraint."¹

The wound in the abdominal wall may be large and jagged, linear, small and rounded, or barely perceptible to the naked eye—like a small scratch. In some penetrating wounds of the abdomen gastric or intestinal contents or flatus may escape through the wound of entry or of exit; a portion of gut or a piece of omentum may prolapse on to the abdominal wall; or blood may pour in a steady or intermittent stream from the wound or saturate the dressings with a pink discharge. The position of the wound of entry may not at first suggest involvement of the abdominal cavity or its contents. It may, for instance, be in the chest, buttock or back.

The signs and symptoms of a penetrating wound of the abdomen are those of shock, internal hæmorrhage, or peritonitis.

The value of straight X-ray films as an aid to diagnosis cannot be sufficiently stressed.

The mortality from penetrating injuries of the small intestine in the cases submitted to operation is about 60 per cent.

Treatment. Every abdominal wound, whether penetrating or not, should be explored, excised and then sutured without tension. Except in moribund patients, every penetrating wound of the abdomen demands an early exploratory operation. When there is more than one wound it is important to deal with those situated on the back, the buttocks or the posterior aspect of the lower limbs before opening the abdomen. To turn a collapsed patient, who has had a laparotomy, on to his side or face in order to gain access to a wound, say,

¹ Gordon Taylor, *War Wounds and Air Raid Casualties*, 1939.

in the back, may on occasion produce a rapid fall of blood pressure which may even prove fatal.

As in subcutaneous injuries of the intestines, the best approach is a long right paramedian para-umbilical incision, and the first step on opening the peritoneal cavity is to control all bleeding.

The treatment of wounds in the mesentery and in the small intestine is in many respects the same as that already described on page 962.

The authoritative article by Haymoud (*Surg., Gynec. & Obst.*, 61:693, 1935) on massive resection of the small intestine should be studied by all those who are interested in this subject. The term "massive" or "extensive," when applied to resections of the small intestine, has been used to indicate excision of lengths of bowel measuring 200 cms. or more. In the War of 1914-1918 there were only five cases of massive resection of the intestine among British soldiers, and these were described in some detail by Gordon Bell (*J. Roy. Army Med. Corps*, 36:351, 1921) and by Wallace (*J. Roy. Army Med. Corps*, 26:802, 1916).

If we discount the dangers of the operation itself and its possible concomitant complications, it may be said that a patient can withstand a massive resection of 33 per cent of the length of the small intestine and expect the digestive tract to return to normal function, that a 50 per cent removal constitutes the upper limit of safety in extensive enterectomy, and that resections above 50 per cent must necessarily be followed by poorer results, although in an exceptional case the health may be better than predicted.

The majority of injuries of the *large gut* are penetrating wounds caused by bullets, fragments of high explosive shells, or by daggers, bayonets and the like. Injuries of the colon without penetration of the abdominal wall are rare. If a large series of cases of penetrating wounds of the abdomen be analysed, the colon will be found to be involved in some 20 per cent and the transverse colon to be the segment most frequently perforated or otherwise damaged.

The mortality from gunshot wounds of the colon is about 70 per cent and that from stab wounds approximately 30 per cent. If at operation the colon is found to be perforated, it is customary to give an immediate intramuscular injection of combined tetanus and gas bacillus antitoxin. The first requisite is, of course, to find and

control all bleeding points. Blood and faeces should be removed by suction or by gentle mopping with swabs soaked in warm saline solution.

In closing tears in the mesocolon special care must be exercised to avoid interference with the blood supply of the bowel. In most cases intraperitoneal wounds of the colon can be closed with a two-tier suture; but in the following instances exteriorisation of the involved segment of bowel plus temporary drainage or a Mikulicz type of operation is indicated:

1. When a portion of the colon is in a condition of infarction.
2. When the mesocolon is stripped from the bowel, is the site of an extensive hæmatoma, or is actively bleeding.
3. When a segment of the large gut is severely crushed and its viability is imperilled.
4. When a segment of the colon is riddled with multiple wounds
5. When there are extensive wounds, and more especially when these are situated at the mesocolic attachment or retroperitoneally. These retroperitoneal injuries of the colon with consequent infection of the extraperitoneal tissues are much more likely to be fatal than intraperitoneal wounds.

CHAPTER 2

TUMOURS OF THE JEJUNO-ILEUM

Neoplasms of the small intestine are seldom encountered in surgical practice and their rarity is confirmed by the paucity of published cases. Schofield (*Brit. J. Surg.*, 18:84, 1930) maintains that there are very few surgeons who when investigating a vague abdominal condition would include these growths in their differential diagnosis, and that students are universally taught that cancer practically never involves the small bowel although it is the commonest of small intestinal tumours. Neoplasms in this situation are therefore likely to be regarded as pathological curiosities of only academic interest, and thus they remain until the occasion arises when at operation the surgeon is suddenly confronted by one of them. The tumour then ceases to be of mere theoretical interest, assumes practical importance, and demands immediate attention.

It is highly desirable, both for statistical and other reasons, for the surgeon to determine with unfailing accuracy the exact position of the growth in the intestine. We are especially indebted to Mall (*Bull. Johns Hopkins Hosp.*, 9:197, 1898) and to Monks (*Tr. Am. Surg. Ass.*, 21:405, 1903) for much of our knowledge of intestinal localisation. The average length of the small gut is 23 feet; the upper two-fifths are jejunum and the lower three-fifths are ileum. The small intestine is entirely surrounded by peritoneum except for a very small area at the mesenteric attachment. The length of the gut is variable, the extremes being 15 and 30 feet. At operation the surgeon of experience should be able to tell at a glance what portion of the intestine it is that he is holding between his fingers (figs. 228 and 229).

Tumours of the jejuno-ileum may be classified as follows:

1. Benign Tumours: (a) adenoma; (b) myoma; (c) lipoma; (d) fibroma; (e) adenomyoma; (f) hæmangioma; (g) myxoma; (h) myxofibroma; (i) neurofibroma; (j) endothelioma; (k) teratoblastoma.

2. Malignant Tumours: (a) carcinoma—adenocarcinoma; (b) sar-

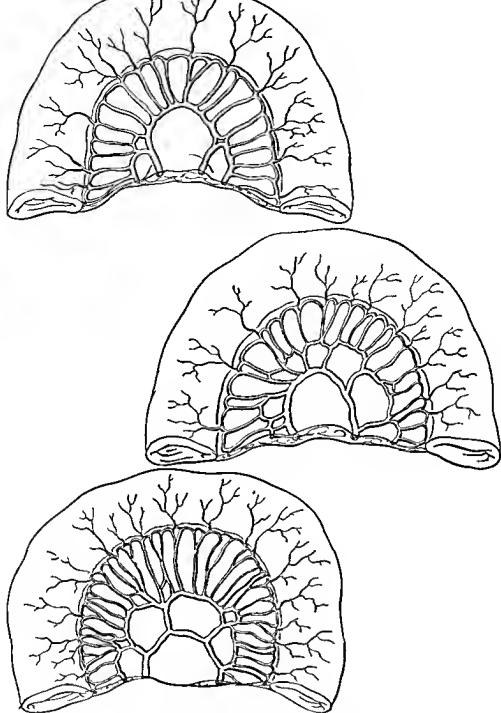


FIG 228.—INTESTINAL LOCALISATION.

Top sketch shows a loop of intestine about three feet from the duodenojejunal flexure. Note that the intestine is of large size, the mesenteric arterial loops are primary, the vasa recta are large, long and regular in distribution. The translucent spaces, *i.e.*, the lunettes, between the vessels are extensive. Below, the mesentery is streaked with fat.

Middle sketch shows a loop of intestine at six feet. As compared with the above figure, the gut is somewhat smaller, and the vascularity of the intestine and mesentery is less. Secondary arterial loops are a prominent feature. The vasa recta are smaller. The lunettes are also present, but they are not so large as in the figure above.

Bottom sketch. A loop of intestine at nine feet. Here the secondary loops are large; the vasa recta are somewhat irregular and show branches; no lunettes are present; and the mesentery is streaked with fat. (After Monks.)

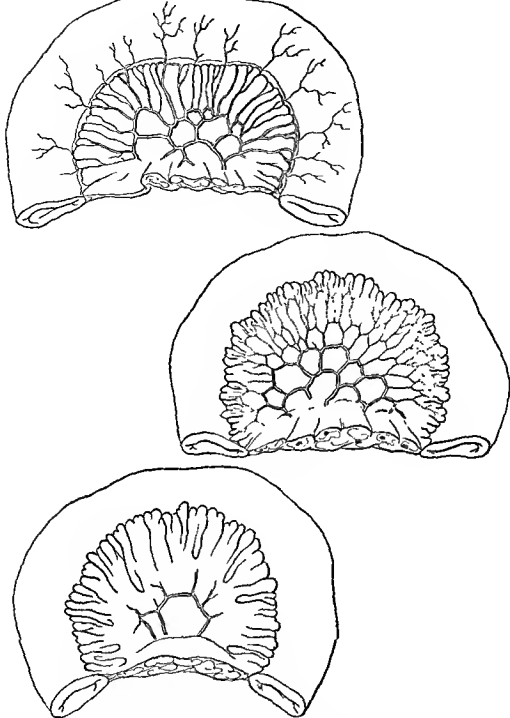


FIG. 229.—INTESTINAL LOCALISATION.

Top sketch. A loop of intestine at twelve feet. The vessels are smaller; the primary loops are lost in fat, but secondary and even tertiary loops are visible. The vasa recta are shorter, more irregular and branching.

Middle sketch. A loop of intestine at seventeen feet. The mesentery is opaque and tabs of fat begin to appear along the mesenteric border of the gut. The vessels are represented by a somewhat complicated network and are seen with difficulty in the thick fat of the mesentery.

Bottom sketch. A loop of intestine at twenty feet. The gut appears to be thick and large, the mesentery is fatty and opaque, and numerous tabs of fat are present. The vessels are seen with difficulty and are represented by grooves in the fat. (After Monks.)

coma: (i) fibrosarcoma; (ii) leiomyosarcoma; and (iii) lymphosarcoma.

3. Carcinoid Tumours.

BENIGN TUMOURS OF THE SMALL INTESTINE

Benign tumours are found approximately three times more frequently in the colon than in the small intestine, and malignant growths of the jejunum-ileum are twice as common as the innocent variety. In Kemp's collected series (*Surg., Gynec. & Obst.*, 25:54, 1917) of 119 cases of benign tumours of the small and large intestine, only 47 were situated in the small bowel, whilst Rankin and Newell (*Surg., Gynec. & Obst.*, 56: Oct. 1933) in analysing 93 cases of new growths of the small intestine treated at the Mayo Clinic, showed that 60 of these were malignant and 33 were benign. It is nevertheless probably true to state that innocent new growths of the jejunum-ileum occur more frequently than statistics would have us believe, as there must be an appreciable number of cases which on account of the absence of symptoms, physical signs or radiological evidence, pass undetected. The commonest of these tumours in order of frequency are: adenoma, myoma, fibroma, lipoma and hæmangioma. Other rare forms have been described, such as myxoma, myxofibroma, neurofibroma, and teratoblastoma. The majority of ileomyomata are probably sarcomatous, as Klopp and Crawford (*Ann. Surg.*, 102:726, 1935), in discussing three cases which occurred in their practice, have sought to prove.

Benign tumours of the jejunum-ileum affect all parts of the small gut, but the last quarter of the ileum is the commonest site.

The submucous type grows into the lumen of the bowel, while the subserous variety extends beneath the peritoneal investment of the gut. The tumours may be sessile or pedunculated; they vary greatly in size from that of a pea to that of a tumour which may be readily felt per abdomen; they may be single or multiple and in the latter case they may affect a considerable portion of the intestinal tract—polyposis; they have all the macroscopical and microscopical features of similar tumours found in other parts of the body; and some of them undergo malignant transformation. The submucous tumours and more especially the fibromata and lipomata often produce an intussusception.

Diagnosis. A correct pre-operative diagnosis has rarely been made; the majority of the cases are discovered accidentally at operation or in the post-mortem room.

There are no characteristic signs and symptoms of a benign tumour of the small intestine, and skiagrams of the gastro-intestinal tract afford but little aid in diagnosis except in the presence of obstruction. The symptoms may be mild and persistent abdominal discomfort, nausea, flatulence, and indigestion, pointing to a diagnosis of chronic appendicitis, gall-bladder disease or constipation; or again they may be severe and recurrent. There may be cramp-like seizures associated with vomiting and meteorism, resembling renal, biliary or intestinal colic or intestinal obstruction. Blood may be passed in the stools and, on occasion, anemia may be pronounced. Rarely does the tumour grow so large as to be palpable on physical examination.

I have had personal experience of only one case of benign tumour of the small intestine. The patient was a woman aged 42, who had elsewhere previously undergone three major abdominal operations within a period of eighteen months—appendicectomy, cholecystectomy and exploratory operation for the division of adhesions. The symptoms before and after these operations were the same, namely, severe recurrent epigastric pain associated with attacks of bilious vomiting. As the symptoms became more alarming, she was admitted to the Royal Waterloo Hospital for observation and investigation. These investigations threw but little light on the diagnosis, and following an attack of sub-acute obstruction exploration was again performed. An intussusception, 6 inches from the duodeno-jejunal flexure, was discovered, and as this was irreducible the involved portion of intestine was resected, after which an end-to-end anastomosis was carried out, restoring intestinal continuity. The tumour causing the intussusception was a hard, round, cherry-like pedunculated body which, on microscopical examination, proved to be a fibro-adenoma. The patient made a quick recovery and two years later was reported to be in good health.

Treatment. If the tumour is small, local excision will suffice; but if it is large or has produced an irreducible intussusception, resection followed by end-to-end anastomosis or closure of both ends of the gut with lateral anastomosis will be required. The results of this operation are most gratifying.

Rankin and Newell (1933) reported that in their series of 35 cases there were no operative deaths. In some cases enucleation was performed; in others resection; and in following up the results the permanence of cure by surgery was fully established.

MALIGNANT TUMOURS OF THE SMALL INTESTINE

Carcinoma. According to Ewing, malignant tumours of the small intestine comprise approximately 3 per cent of all those occurring in the gastro-intestinal tract. Cameron (*Ann. Surg.*, 108:203, 1938) in analysing 200 cases of primary malignancy of the jejunum and ileum showed that carcinomata outnumbered sarcomata in the proportion of 5 to 4, and malignant carcinoids in the proportion of 8 to 1. In Raiford's series (*Radiology*, 16:253, 1931) of 34 cases, there were 20 carcinomata and 14 sarcomata. Medinger's total of 22 cases (*Surg., Gynec. & Obst.*, 69:299, 1939) comprised 16 primary carcinomata and only 6 primary sarcomata. Although primary carcinomata may involve any portion of the small intestine, they show a predilection for the proximal quarter of the jejunum and the distal quarter of the ileum, the former site being the more common. This statement is confirmed by Keifer (*New England J. Med.*, 208:1042, 1933) who, in reporting a series of 8 cases, stated that 6 occurred in the jejunum and 2 in the ileum, and by Rankin and Mayo (*Surg., Gynec. & Obst.*, 50:939, 1930) who described 35 cases in which 21 were situated in the jejunum and 14 in the ileum.

Pathology. Macroscopically there are three types of carcinoma of the small bowel:

1. The annular constricting adenocarcinoma which resembles the typical cicatrising growth of the sigmoid colon.
2. The polypoid or papillary tumour which grows into the lumen of the bowel and frequently causes an intussusception.
3. The rounded tumours growing away from the intestinal lumen into the general peritoneal cavity.

These tumours make themselves known by two groups of symptoms: those occurring before the onset of obstruction, and those following the advent of sub-acute or acute obstruction.

Obstruction, however, does not declare itself until stenosis becomes almost complete, i.e., at a late stage in the disease, owing to the fluid

nature of the bowel contents. Malignant polypoid tumours of the jejunum and ileum are, as stated above, prone to produce intussusception. This occurred in 23 per cent of the tumours of the jejunum reported by Raiford (*Arch. Surg.*, 25:122, 1932) and in 30 per cent of the cases reported by Staemmler (1924).

Carcinomata of the jejuno-ileum may ulcerate and when they do so they may give rise to a grave form of anæmia; they metastasise liberally and eagerly at a comparatively early stage to the mesenteric lymph nodes; and they are a rare cause of intestinal perforation and acute spreading peritonitis. The most common operative finding is a small scirrhous ring-like cancer of the bowel, with the proximal portion of the intestine dilated, hypertrophied and somewhat stiffened with œdema; the distal gut attenuated and collapsed; and a widespread involvement of the mesenteric and retroperitoneal lymph nodes. Metastases in the liver, in the peritoneum and elsewhere, are manifestations of the terminal phase. Carter (*Ann. Surg.*, 102:1019, 1935) maintains that the surgeon should not be deterred from his purpose by the presence of enlarged nodes in the mesentery and retroperitoneum, and would advise resection in all cases where this is feasible, as the swollen glands may be only inflammatory in character.

To date I have operated upon four primary carcinomata of the small intestine; three of the growths were situated in the jejunum and one in the ileum. Two of the jejunal tumours were irremovable on account of massive infiltration of the lymph glands and mesentery, and in both cases a palliative duodeno-jejunostomy was performed; but the third one, a recent case, which was a constricting carcinoma situated 16 inches from the ligament of Treitz, lent itself to excision and lateral anastomosis. Figures 230 and 231 are vivid representations of the specimen. The patient with the ileal carcinoma, a man of 51 upon whom I performed resection, died from pulmonary embolism on the tenth day after operation. The specimen of this carcinoma of the distal ileum is preserved in the Hunterian Museum of the Royal College of Surgeons and is illustrated on page 610 of *Post-Graduate Surgery*.

Diagnosis. As in the case of benign tumours, the symptoms may be divided into two groups:

1. Those which occur before obstruction takes place; and

2. Those which follow upon partial or complete occlusion of the bowel.

In the former group are included the symptoms which are commonly observed with any intestinal malignancy, such as pain, which may be diffuse, shifting, dull and aching, or sharp and cramp-like; nausea; vomiting with partial relief of symptoms; progressive anæmia; loss of appetite; loss of weight; distension; and a palpable mass. Although absence of free hydrochloric acid in the aspirated gastric juice and the presence of occult blood in the stools are mentioned in many articles as common findings, these are not constant and are clearly not specific in the diagnosis of cancer of the small intestine. The symptoms in the second group may be divided into those which accompany slowly progressive obstruction, and those of acute obstruction. Intermittent obstruction may occur with vomiting, colicky abdominal pain, distension and dehydration. The attack may subside after the passage of a few hours, only to recur at steadily shortening intervals. With the onset of acute obstruction, pain becomes sharp, spasmodic, and agonising to a degree, vomiting is usually profuse, and visible peristalsis may be noted. Distension is only noticeable when the blockage occurs in the lower coils of the ileum. A barium meal X-ray examination of the intestines is generally recognised as the best positive means of diagnosis, but the interpretation of the skiagrams is often difficult. The patient should be given a barium meal on a fasting stomach, and films of the abdomen should be taken at hourly intervals for six hours.

Medinger asserts that the radiologist is seldom able to diagnose more than the presence of an organic lesion in the small gut and that in 50 per cent of proved cases X-ray evidence has been negative. Important X-ray evidence supporting the diagnosis would include the following:

1. Constant filling defect in the small intestine.
2. A point of intestinal constriction, as in partial obstruction.
3. Dilatation of the stomach or small intestine with barium retention.

The amount of gas, fluid and distension seen on the X-ray films will depend on the level of the obstructing lesion and the degree of obstruction which is present.

In the differential diagnosis the conditions most likely to be con-

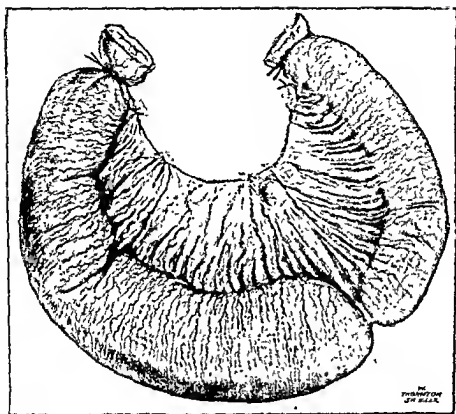


FIG. 230.—CARCINOMA OF THE JEJUNUM—OPERATION SPECIMEN.

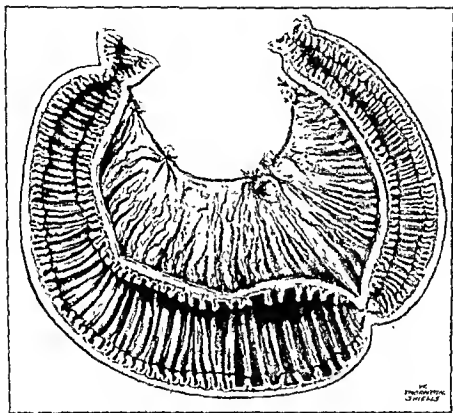


FIG. 231.—CARCINOMA OF THE JEJUNUM.

Same specimen as depicted in Figure 230 cut open to show the small ring-like stenosing cancer which is producing a degree of obstruction of the jejunum.

fused with cancer of the jejunum-ileum are benign tumour, obstruction due to adhesions, spontaneous intussusception, volvulus, appendicitis, regional enteritis and malignant disease of the cæcum or ascending colon.

Prognosis. Even following extensive resection, the outlook is bad. Keifer gives the average duration of life after resection as one year, and Mayo and Nettrour (*Surg., Gynec. & Obst.*, 65:303, 1937) as eighteen months. In Keifer's series of 11 cases there was only one patient alive and well five years after resection for a carcinoma of the proximal jejunum. The resection rate is between 60 per cent and 70 per cent, and the operative mortality about 30 per cent to 40 per cent. The prospect of a five-year cure following resection is not higher than 5 per cent.

Treatment. Patients with carcinoma of the small intestine are generally admitted to hospital in a debilitated and anæmic condition, or in a state of chronic or acute intestinal obstruction. The pre-operative measures will therefore include blood transfusion, intravenous administration of glucose-saline solution, and decompression of the proximal intestine with an indwelling duodenal tube.

The abdomen is explored through an ample right paramedian incision and the viscera are methodically examined. If the growth proves to be irremovable, a side-tracking operation should be carried out to forestall or at least to delay obstruction of the bowel. But where resection is feasible, an attempt should be made to eradicate as widely as possible both the disease and its extensions to the adjacent lymph nodes. This is achieved by removing the tumour with a wide margin of healthy bowel both above and below it, and a large V-shaped portion of adjacent mesentery. The intestinal continuity is restored by performing an *end-to-end or side-to-side anastomosis*.

Carcinoma of the jejunum is commonly situated from 6 to 24 inches distal to the ligament of Treitz. In these cases following resection it is better to close both ends of the gut and to perform side-to-side duodeno-jejunostomy rather than to attempt what would in fact be a difficult end-to-end anastomosis.

The steps of this operation are briefly these: After the affected segment of bowel has been resected and the proximal and distal ends of the cut intestine have been securely closed, the anterior leaf of the mesocolon is incised and the third portion of the duodenum is

mobilised, after which the distal jejunum is swung to the right in an anti-clockwise direction so that it lies without any tension by the side of the duodenum. A side-to-side anastomosis is then carried out in the usual manner, and when this is completed the upper edge of the opening in the mesocolon is sutured to the duodenum anteriorly, and the cut edge of the mesentery of the distal jejunum is stitched to the peritoneum of the posterior abdominal wall.

The treatment of growths occupying the last foot or two of the ileum may be outlined as follows:

1. Inoperable—ileo-colostomy.

2. Operable—(a) wide resection of the portion of the ileum containing the growth with a generous wedge of mesentery, this being followed by closure of both ends of the intestine and by the performance of ileo-cæcostomy; or (b) right-sided hemi-colectomy, as for carcinoma of the cæcum, the operation being completed by anastomosing the cut end of the ileum to the transverse colon.

The amount of distal ileum sacrificed in this operation will of course depend upon the position of the growth; but the proximal section of the gut should always be at least 6 inches above the growth.

Sarcoma. Less than 250 cases of sarcoma of the jejuno-ileum have been reported to date. Sarcoma is more common in the small than in the large intestine, and does not involve the jejunum and ileum so frequently as does carcinoma. Persons between the ages of 30 and 40 are more prone to be affected, although the disease has been known to occur in infants and in the aged. No portion of the small bowel is exempt from this type of growth, although Cameron (*Ann. Surg.*, 108:203, 1938) has shown that the commonest site is the distal quarter of the ileum, then in order of frequency the proximal quarter of the jejunum and the middle third of the small intestine.

The tumours are either fibrosarcomata, leiomyosarcomata, or lymphosarcomata; but only one-third of these are of connective tissue or unstriped muscle type, while two-thirds are of lymphoid structure. According to Cameron, sarcomata of the small intestine exhibit large and small extra-luminal and intra-luminal masses, also large and small annular formations, some with and some without narrowing of the lumen of the bowel.

There is one form which transforms an appreciable length of small intestine into a rigid thick-walled tube. It is commonly stated

that the sarcomatous tumours of the jejunum-ileum rarely produce obstruction, but in point of fact stenosing growths occur three times more frequently than the diffuse annular type which may at times cause dilatation of the bowel instead of constriction. Metastases to the regional mesenteric lymph nodes and to the liver occur at an early date.

Signs and Symptoms. These are in some measure determined by such factors as the position, size and extent of the primary growth, the presence of metastases, and whether or not the small gut is partially or totally obstructed. The onset of the symptoms may be insidious: weakness, loss of weight, anorexia, dyspepsia, and recurrent abdominal pain; or again, it may be sudden and severe, as in intussusception, in occlusion or in acute perforation.

On abdominal examination the findings may be negative or they may be those of a movable or fixed tumour, or obstruction, or of spreading peritonitis. The incidence of palpable sarcomata of the jejunum-ileum is high and greatly exceeds that of carcinomata, the respective incidence being 65 per cent and 29 per cent. Many of the patients seek medical advice when there is a large abdominal tumour and when anæmia and debility are marked.

Prognosis. Approximately two-thirds of the cases are operable. The operative death-rate is 30 to 40 per cent, and only about 5 per cent of those subjected to radical surgery are alive at the end of five years.

Treatment. In fully one-third of the cases the growth is so fixed and firmly matted to surrounding structures, and metastases to the mesenteric lymph nodes are so extensive and diffuse, that a palliative lateral anastomosis is all that can be offered in the way of relief. Radical resection should be carried out whenever possible, even though it may be evident at the time that this will afford but temporary palliation.

Post-operative deep X-ray treatment is frequently administered to these cases, but it is difficult at the present time to assess its value.

Carcinoid Tumours. Carcinoid tumours, which were first described by Lubarsch (*Arch. f. path. Anat.*, 111:280, 1888), have excited a great deal of interest and controversy among pathologists during the last two decades. They are rare tumours, approximately fifteen to twenty times rarer than carcinomata or sarcomata of the small intes-

tine, but in their origin, structure and method of spread they present many interesting features which account for the degree of attention they have attracted. They may arise in any portion of the intestinal tract, but are most frequently found in the vermiform appendix.

Porter and Whelan (*Am. J. Cancer*, 36:343, 1939) state that the incidence of the small-bowel tumours is less than half that of carcinoids in the appendix. The former have a predilection for the terminal ileum, tend to cause obstruction, and not infrequently metastasise to the regional lymph nodes.

On microscopical examination the cells bear a superficial resemblance to basal-celled carcinoma, and contain granules which reduce a solution of ammoniacal silver; hence they are called argentaffine. They stain with chromic acid, and are therefore chromaffine. All argentaffinomata are potentially cancers, but their grade of malignancy is low. In 152 cases collected by Humphreys (*Am. J. Cancer*, 22:765, 1934) metastases were present in 24.4 per cent. These tumours probably arise from the Nicolas-Kultschitzky cells in the gastro-intestinal mucosa, but the exact origin or function of these cells is by no means clear. The evidence appears to be fairly well divided between entodermal and ectodermal proponents. This subject receives full consideration from Raiford (*Am. J. Cancer*, 18:803, 1933); Gosset and Masson (*Presse méd.*, 22:237, 1914); and Quarry Wood (*Brit. J. Surg.*, 22:766, 1936).

Carcinoids of the jejunum-ileum are usually small nodular or sessile submucosal growths; rarely do they invade the entire circumference of the bowel. In about 30 per cent of cases they are multiple in origin. They usually cause obstruction either from intra-luminal encroachment or by a puckering distortion of the gut wall in contradistinction to a complete ring-like stenosis.

On section the tumour presents a yellowish or a grey-yellow colour which is very strikingly characteristic (fig. 232). According to Cook (*Arch. Surg.*, 22:568, 1931), the average age-incidence is about 55 years, and the tumour is slightly more common in males.

There are no typical signs and symptoms of carcinoid growths of the small intestine; but the disease should be considered in the differential diagnosis of all chronic low small-gut obstructions in which there is radiological evidence of an intrinsic lesion of the bowel. It is

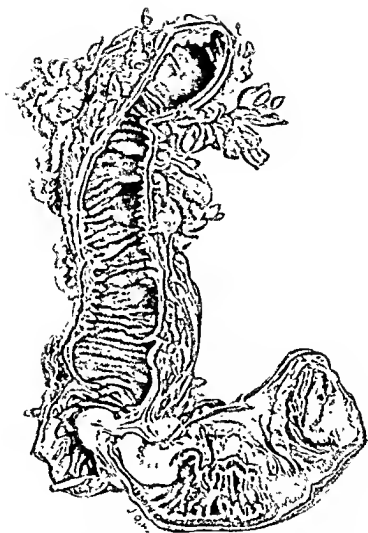


FIG. 232.—CARCINOID TUMOUR OF THE INTESTINE.
(By courtesy of Mr. Quarry Wood.)

true that carcinoma will present similar symptoms and that it will generally be impossible to distinguish between the two until the tumour has been sectioned.

Treatment. At operation the diagnosis will be that of malignancy of the small bowel and the nature of the tumour will not be suspected until the cut surface of the specimen has been examined. Multiple growths will rarely be recognised during exploration, and even if they are it will often be impossible to deal with them satisfactorily.

Operable solitary growths demand excision, while the irremovable mass will call for a palliative side-tracking procedure.

CHAPTER 3

REGIONAL ENTERITIS

Regional enteritis is a chronic inflammatory disease of unknown ætiology, which may involve any portion of the gastro-intestinal tract, although the terminal ileum is the commonest site. It is of great surgical interest, since complications such as obstruction, perforation, fistula, and abscess formation are apt to occur in the later stages of the disease.

The lesion has been discussed in medical papers under a multiplicity of titles, e.g., infective granuloma (Mock), chronic interstitial enteritis (Dalziel), non-specific granuloma (Moschcowitz and Wilensky), chronic cicatrising enteritis (Harris, Bell and Brunn), regional ileitis (Crohn, Ginzburg and Oppenheimer), ileo-colitis ulcerosa chronica (Rosenblate, Goldsmith and Strauss), pseudo-cancer (Le Dentu), chronic ulcerative enteritis (Corr and Boeck), and regional enteritis (Brown, Bergen and Weber). To-day the terms most favoured are Crohn's disease, non-specific granuloma of the intestine, and regional enteritis. I prefer the last-named, as it does not assume too much, it indicates the non-specificity of the lesion, and it determines that the lesion is inflammatory and not neoplastic.

Combe (*Tr. Roy. Coll. Phys.*, 4:16, 1813) is accredited with the first description of terminal ileitis, and in the light of our present knowledge his article, *A Singular Stricture and Thickening of the Ileum*, is worthy of perusal.

Virchow (*Arch. f. path. Anat.*, 5:335, 1853), Norman Moore (*Tr. Path. Soc. Lond.*, 34:112, 1882) and W. J. Mayo (*Northwest. Lancet*, 13:7, 1893) were some of the earliest writers to describe non-malignant inflammatory tumours of the cæcum and lower coils of the ileum. Among others, Braun (*Arch. f. klin. Chir.*, 63:378, 1901), Dalziel (*Brit. M. J.*, 2:1068, 1913), Tietze (*Ergebn. d. Chir. u. Orthop.*, 12:211, 1920), Moschcowitz and Wilensky (*Am. J. M. Sc.*, 166:48, 1923) and Mock (*Surg. Gynec. & Obst.*, 52:672, 1931) attested to the recognition of a definite group of non-specific granulomatous

tumours of the intestine as distinct from those of heterogeneous but specific causation, such as syphilis, actinomycosis, amebiasis, diverticulitis, etc. Clark (*Proc. Staff Meet. Mayo Clinic*, 13:535, 1939) states that among the four cases of non-specific granuloma of the intestine recorded by Moschcowitz and Wilensky in 1923 is one in which the last 12 inches of the ileum was involved. From the very accurate data supplied this may be recognised as being identical with the regional ileitis described in 1932 by Crohn, Ginzburg and Oppenheimer (*J. Am. M. Ass.*, 99:1323, 1932). Few articles in modern medical literature have aroused more interest than the last mentioned, and it would be fair to state that much of our present knowledge of the clinical and pathological aspect of hypertrophic non-specific inflammatory lesions of the terminal ileum and of the adjacent large bowel is attributable to the exhaustive studies of Crohn and his co-workers at the New York Post-Graduate Medical School. So complete was this original contribution that little has been added since regarding the disease except what would testify to its prevalence and corroborate Crohn's description. Subsequent cases, however, recorded by Harris, Bell and Brunn (*Surg., Gynec. & Obst.*, 57:637, 1933), Colp (*Surg. Clin. N. Am.*, 14:443, 1934), Wilensky (*Surg.*, 6:288, 1939) and others, support the view that the identical inflammatory process may affect any part of the small intestine and may extend into the colon or even in very rare cases into the stomach.

According to Maxwell Lick (*Internat. Abstr. Surg.*, 66:347, 1938), in the six years following the appearance of Crohn's article, nearly 600 cases were reported in more than 100 publications. At the Mayo Clinic between the years 1922 and 1938, no fewer than 69 cases were verified at operation. Wilensky maintains that the number of case-reports which have accumulated in the literature year by year seems to indicate that observers are more alive to the subject and not that there is a progressive increase in the prevalence of the disease, which has in fact actually been found to be less rare than was originally supposed.

Non-specific granuloma of the alimentary tract may occur at any age. The youngest case reported (Koster) was 7 years of age, the oldest being in the sixth decade of life. The highest incidence is observed between the ages of 15 and 40, *i.e.*, during the age-period in which

acute appendicitis and mesenteric adenitis are most prevalent. The disease affects the sexes equally.

Pathology. The macroscopic appearance of the bowel in regional enteritis is not unlike that seen in chronic ulcerative colitis. The serosa is oedematous, reddened, and often covered with greyish-white fibrous strands which may be adherent to other loops or to the parietal peritoneum (fig. 233). All the coats of the gut are greatly thickened (5 to 15 mms.), rigid and fibrotic, while on section they appear white and fleshy. This fibrosing process markedly reduces both the circumference and the lumen of the intestine, and late in the disease it may produce a complete blockage. Obstruction, however, may also be caused by bands and adhesions and by loops of bowel becoming kinked at the sites to which they are attached by newly-formed inflammatory fibrous membranes. The mucosa is for the most part diffusely ulcerated, this ulceration being most noticeable on the mesenteric border. In some cases the mucous membrane between the ulcerated areas is seen to be drawn into bold papillary folds producing pseudo-polypoid masses such as are commonly observed in chronic ulcerative colitis. The mesentery is thickened and shortened and its appearance suggests an acute inflammatory process. The mesenteric glands themselves are often enlarged, but as a rule they do not attain any great size. In an advanced case the bowel may perforate and give rise to a local collection of puss or to an internal or external fistula. Such a fistula may communicate with the abdominal wall or with an adjacent portion of the intestine or other viscera, *e.g.*, the bladder. An external fistula frequently develops when appendectomy is carried out in cases of acute terminal ileitis.

Microscopically the process also simulates chronic ulcerative colitis. Adams describes the microscopical appearances as follows:

The mucosa is usually absent when the submucosal tissues are replaced by vascular granulation tissue with a marked non-specific chronic inflammatory process characterised by an infiltration of lymphocytes, plasma cells, large mononuclears and polymorphonuclear eosinophils. Although the most involved layer seems to be the submucosa, there is in almost all cases a definite involvement of the muscular, serosal layers and the mesentery. The mesenteric glands are usually enlarged and show a similar non-specific chronic inflammatory process. Huge foreign body giant cells with as many as 30 nuclei are occasionally present, a finding that is not observed in ulcerative colitis, and suggest tuberculosis or lues as a causative agent. It is possible that because of some

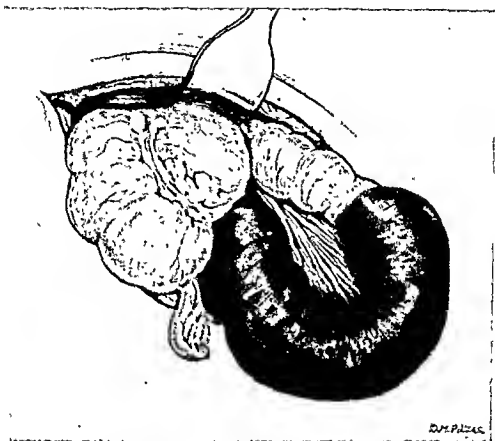


FIG. 233—ACUTE TERMINAL ILEITIS.
(By courtesy of Mr. W. A. Jackman.)

such findings as these, the disease was classified as tuberculosis before this disease became known as a definite clinical and pathological entity not many years ago.¹

Clinical Features. These depend upon many factors, such as the portion of intestine involved, the degree of involvement, the presence of complications, etc. While it is true that in most instances the first impressive manifestations of the disease are massive hæmorrhage, persistent diarrhœa, repeated vomiting, or perforation of the intestine into a neighbouring viscus, it is possible to classify many of the cases under the following headings:

1. *Acute Group.* Here the signs and symptoms are very suggestive of acute appendicitis. Abdominal pain is a predominant feature and may be localised to their right iliac fossa or be fairly diffuse. Fever, rising pulse-rate, nausea, vomiting, diarrhœa, tenderness, rigidity, perhaps a suggestion of a mass in the right lower quadrant of the abdomen, and leucocytosis, are all present. It is not surprising therefore that many cases in this group are subjected to an immediate appendicectomy for "acute appendicitis." Clark, who made a study of 35 cases of regional enteritis admitted to the Mayo Clinic, found that no fewer than 17 of these had had a previous appendicectomy performed elsewhere without any subsequent relief of pain. The appendix may or may not be involved in the inflammatory process and its removal in these cases is a superfluous and sometimes dangerous undertaking. The lesion in the terminal ileum is often overlooked or misinterpreted at operation.

2. *Irritative Group.* The clinical picture here is that of a low-grade enteritis. There is loss of weight, an occasional bout of vomiting, chronic diarrhœa, and later anæmia and asthenia. Nausea and dyspepsia are present, and the patient is afraid to eat for fear of the cramp-like seizures which are so apt to ensue shortly after the intake of food. The temperature is slightly elevated, and there may be night sweats. The diarrhœa, which is one of the most troublesome features, is difficult to control by medicinal means. A palpable mass may slowly form in the right iliac region.

In the earlier stages there may be long periods of freedom from pain and diarrhœa, but as the disease process advances the remissions

¹ Adams, *Surg. Clin. N. Am.*, 17:763, 1937. Courtesy of W. B. Saunders Co.

become less frequent or of shorter duration and symptoms characteristic of intestinal obstruction are superimposed upon those of chronic enteritis.

3. *Obstructive Group.* In some cases the granulomatous condition may have progressed from a stage in which there is an occasional attack of pain in the lower abdomen to one in which the outstanding features are those of sub-acute intestinal obstruction with very little intervening disturbance, while in others diarrhoea becomes incoercible and is then accompanied by severe cramps in the right iliac fossa or in the umbilical region, distension, vomiting and visible peristalsis.

4. *Fistula.* The fourth group is composed of those cases in which a fistula has developed. Symptoms of intestinal obstruction or of irritation may be present or absent. The fistula commonly follows appendicectomy for acute ileitis, and persists until the involved segment of the gut has been widely resected.

The chief signs and symptoms therefore of regional enteritis are pain, diarrhoea, anæmia, vomiting, palpable mass, loss of weight and faecal fistula.

The type of pain is variable; it may be mild, as in cases of chronic indigestion; it may simulate the epigastric distress of peptic ulcer; it may be diffuse or be definitely localised to the umbilical, hypogastric or right iliac region; it may resemble the colic of chronic obstruction; it may be intense, spasmodic and agonising, as in sudden blockage of the gut; or again, during bouts of diarrhoea, it may be cramp-like in character.

Diarrhoea is the next most common symptom. The stools are usually loose and watery, occasionally contain mucus, but are rarely stained with blood although in exceptional cases bulky, tarry motions may be passed. When colicky spasms become severe, bouts of diarrhoea may alternate with periods of constipation.

Anæmia of the microcytic type is present in more than 50 per cent of the patients.

Vomiting occurs when the stage of obstruction is reached, while the evidences of malnutrition and loss of weight are apparent in nearly all the cases.

A palpable mass can often be made out in the right lower quadrant of the abdomen; in Clark's series a palpable mass was present in 23

out of 30 cases, while in Crile's series (*Surg. Clin. N. Am.*, 19:1171, 1939) of 20 cases this sign was positive in six.

Fistula is a distressing complication. As a rule the fistula connects the cæcum or terminal ileum with the abdominal wall, but occasionally the track may unite the bowel with an adjacent loop of gut or with the bladder or some other viscus.

Skiagrams are of the greatest help in making a pre-operative diagnosis of regional enteritis. As Crile has emphasised, any patient who has a demonstrable lesion in the ileum or right colon should be subjected to an X-ray examination of the chest to determine whether or not pulmonary tuberculosis is present. In cases of tuberculosis enteritis skiagrams frequently reveal the presence of phthisis whereas in cases of non-specific granuloma of the intestine the pictures of the chest are negative. In suspected cases a barium enema should be given, after which skiagrams are taken of the cæcum and terminal ileum. At an early stage in the disease the films will reveal a slight fuzziness and an indistinct outline of the terminal ileum, while later on Kantor's "string sign" may be present (*J. Am. M. Ass.*, 103:2016, 1934). The "string sign"—"A thin slightly irregular linear shadow suggesting a cotton string in appearance and extending more or less continuously from the region of the visualised loop of ileum through the entire extent of the filling defect and ending at the ileo-cæcal valve"—is present in most of the well-developed cases, and although not pathognomonic of ileitis is highly suggestive of its presence. A fully illustrated and well-written account of the *Roentgenologic Manifestations of Regional Enteritis* is given by Weber (*Proc. Staff Meet. Mayo Clinic*, 13:545, 1938).

The stools should be examined for occult blood, bacteria, amœbæ, etc. In regional enteritis occult blood may or may not be present, and non-specific organisms can be recovered in samples of the feces.

Differential Diagnosis. Regional enteritis must be distinguished from acute appendicitis, tuberculous enteritis, syphilitic enteritis, actinomycosis of the ileo-cæcal region, chronic right-sided ulcerative colitis, amœbiasis, diverticulitis, and neoplasms of the small intestine and cæcum. In the acute phases of the disease a diagnosis of acute appendicitis is frequently made, whereas during the more chronic stage the two conditions most often mistaken for non-specific granuloma are tuberculous enteritis and chronic ulcerative colitis.

Treatment. The majority of cases of acute ileitis—or, shall we say, fulminating acute ileitis—cannot be distinguished clinically from cases of acute appendicitis, or at least from certain abdominal catastrophes which clearly demand prompt surgical intervention. Laparotomy may be, and in fact often is, the only means of arriving at a correct diagnosis in such cases.

As soon as the peritoneum is opened the surgeon should recognise the pathological lesion present and he should without any hesitation return the cæcum and coils of affected ileum to the abdomen. The wound is then closed without drainage of the peritoneal cavity. The appendix must on no account be removed, nor should any short-circuiting operation be carried out at this stage. The post-operative treatment should be conducted on the Ochsner plan, as for acute peritonitis.

In many of these cases the condition will no doubt resolve satisfactorily, possibly never to be heard of again. Crohn (*Am. J. Surg.*, 46:74, 1939), however, drawing from his extensive personal experience of 130 cases of regional enteritis, states that in a number of instances complete resolution may not occur since some patients eventually develop the complete clinical picture of a chronic regional enteritis with mass formation, fistula, and even sub-acute obstruction, although no doubt it may take many years before this indolent granulomatous malady presents itself with obvious and manifest symptoms. All authorities on this subject are agreed that in the presence of definite acute regional enteritis, appendicectomy should not be carried out in view of the considerable risk of thereby establishing an external fistula. Marshall (*Lahey Clinic Bull.*, 1:15, 1939) says: "Of 14 of our patients who had had appendicectomy before coming to the Clinic, six had an external fistula."

There is no satisfactory form of medical treatment for cases of the chronic type, for those neglected patients who have an abdominal wall riddled with multiple fistulous tracks, or for those who on account of the extent of the lesion and widespread involvement of the intestine are unsuitable candidates for massive resection.

Medical measures include a non-roughage but abundant and nutritious diet, vitamin replacement therapy, rest in bed, intestinal sedatives, opiates, sunlight treatment and blood transfusions. It must, however, be admitted that all that medical therapy can afford in the

chronic stages is some temporary relief of symptoms; it has no effect in retarding the inexorable progress of the disease.

At present the only satisfactory type of treatment in the sub-acute and chronic stages from the standpoint of complete recovery is resection of the involved segment of bowel together with a fairly extensive margin of healthy intestine both above and below the lesion. This resection would, of course, include a wide margin of mesentery. The best results are seen when early removal of the lesion is carried out on the lines indicated for cases of malignant tumours of the bowel. When the disease involves the terminal ileum, the adjacent mesentery, and possibly the cæcum, as occurs in some 80 to 90 per cent of cases, the most satisfactory operation is a one-stage or two-stage right-sided hemi-colectomy as conducted for cancer of the cæcum. In the one-stage operation, which should be reserved for patients who are deemed to be good operative risks, the ileum is transected fully 12 inches proximal to the visible and palpable margin and spread of the disease, the proximal end of the ileum is securely turned in and closed, and a wide margin of the mesentery is resected together with the terminal coils of ileum, the cæcum, the ascending colon and the proximal one-third of the transverse colon. The operation is completed by performing a side-to-side ileo-transverse colostomy with the aid of intestinal clamps.

The mortality of this radical resection is about 15 per cent, but fully 90 per cent of the patients who survive this operation show a return to perfect health and function.

By the two-stage method, ileo-transverse colostomy is undertaken as a primary procedure and resection is deferred until the patient's condition is sufficiently improved to enable him to withstand it—usually after an interval of about six weeks.

The ileo-colostomy may be performed in a number of ways, but I prefer to divide the ileum a foot or two above the diseased segment of gut, and after closing the distal end of bowel to anastomose the cut proximal end of the ileum with the transverse colon by the end-to-side method. Labey, on the other hand, advocates resection of the terminal ileum, cæcum and ascending colon by the plan devised by Mikulicz for the left colon. The steps of this operation are as follows: The affected loop of terminal ileum is resected, together with the cæcum and the ascending colon, and a Mikulicz spur is formed be-

tween the terminal ileum and the end of the transverse colon, and brought out through the abdominal incision. The loop of ileum is staggered to permit of immediate drainage of the intestine with a glass tube which is tied in at the end of the ileum. After one week the spur between the ends of the ileum and colon is gradually crushed through by means of an enterotome. Eight weeks later the patient is re-admitted to hospital for extraperitoneal closure of the enterostomy opening which is composed of the ends of the transverse colon and the ileum. Marshall in a review of 13 cases treated by this method states that there were no post-operative deaths and that the subsequent course of these cases was uneventful and extremely gratifying. Marshall considers that the operative risk is considerably reduced by using this two-stage method of resection, and in the majority of his patients health was completely restored. Recurrences, which are stated to occur in 7.7 per cent of the cases, are probably due to incomplete removal of the affected bowel and adjacent mesentery, in other words, to a niggardly resection and the overlooking of multiple lesions when these are present. The small intestine may be involved in intermittent parts, the gut between such areas being normal.

Short-circuiting procedures alone, which have a mortality of about 10 per cent, have been recommended as an alternative to radical resection, but it is well to remember that such palliative operations are doomed to failure in fully 50 per cent of cases.

By performing a palliative ileo-colostomy the patient may be freed from symptoms, but he is not freed from the disease. Nevertheless, in the presence of certain complications such as perforation, fistula, abscess formation, obstruction, etc., the surgeon may have no choice since intestinal resection may be technically impossible. In such circumstances a measure of relief may often be afforded by anastomosing the healthy portion of the ileum to the transverse colon in order to shunt the intestinal contents away from the diseased area which may be inextricably welded to neighbouring structures.

CHAPTER 4

ACUTE INTESTINAL OBSTRUCTION: GENERAL CONSIDERATIONS

Success in treatment of acute intestinal obstruction depends largely upon early diagnosis, skilful management of the case, and an appreciation of the fact that it is just as important to treat the effects of the blockage as its cause. Treatment is not necessarily synonymous with laparotomy, since in certain instances cure may be brought about by simple non-operative measures. When the condition is recognised and treated in its early stages, the immediate and late results are extremely gratifying; but in the late cases, when the distended gut has become seriously damaged and systemic effects are obvious on examination, relief of the obstruction per se is often not sufficient to prevent a fatal issue.

DEFINITION

Acute intestinal obstruction is divided into two main types: (1) mechanical, and (2) paralytic.

In *mechanical* obstruction, the intestinal contents are prevented from passing along the bowel by an actual obstruction of the lumen of the gut.

Mechanical obstruction is divided into simple obstruction and strangulation. In simple obstruction there is a complete blockage to the passage of intestinal contents, and in strangulation there is, besides the obstruction of the lumen, an obstruction to the blood supply of the obstructed bowel.

In *paralytic* ileus the intestinal contents do not pass along the bowel because the intestinal muscle cannot provide the necessary propelling force.

CLASSIFICATION

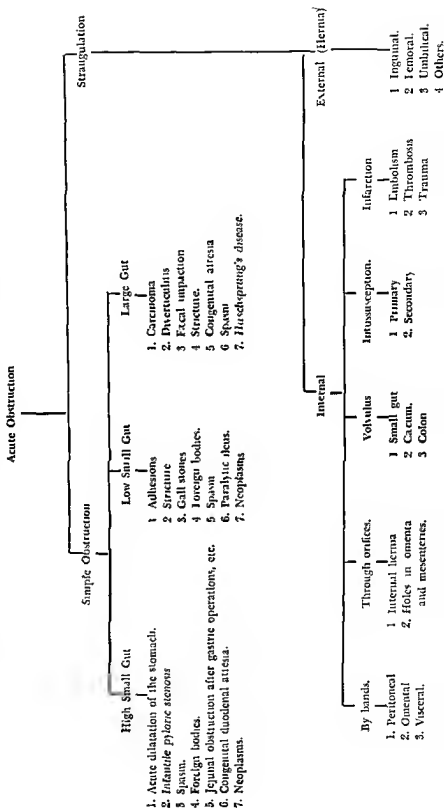
The main types of obstruction from the standpoint of causative factors are: (1) mechanical; (2) nervous, and (3) vascular.

TABLE I
CLASSIFICATION AND TREATMENT OF INTESTINAL
OBSTRUCTION
(Wangensteen)

<i>Clinical Classification</i>	<i>Pathologic Classification</i>	<i>Treatment</i>
I. Mechanical A. Narrowing of lumen 1. Stricture of bowel wall (a) Congenital { atresia imperforate anus (b) Acquired { inflammatory traumatic vascular neoplastic 2. Obturation 3. Compression from without especially pelvis and retroperitoneal duodenum	Simple except in neoplastic strictures of the colon	Operation, preceded by suction for decompression in late cases, except in occlusion of the colon
B. Adhesive bands { congenital inflammatory traumatic neoplastic	Simple or strangulation	Suction, operation for persistent obstruction and in strangulation
C. Hernia 1. External 2. Internal D. Volvulus E. Intussusception F. Errors in development of the intestine giving rise to intestinal obstruction	Strangulation	Early operation
II. Nervous (physiological) A. Inhibition ileus (paralytic) adynamic B. Spastic ileus—dynamic	Simple	Suction
III. Vascular Thrombosis and embolism of mesenteric vessels	Strangulation	Early operation

TABLE 2

CLASSIFICATION OF TYPES AND CAUSES OF ACUTE OBSTRUCTION (COKKINIS)



Wangensteen (*Bowel Obstructions*, p. 79, 1937) states that a satisfactory classification for both clinician and pathologist can only be made by correlating in the more common types of obstruction the factors of causation and pathological appearances, as indicated in table 1.

Cokkinis's classification of the types and causes of acute intestinal obstruction is given in table 2.

There are five common causes of intestinal obstruction, namely, strangulated external hernia, carcinoma of the colon, intussusception, adhesions, and internal strangulation. In Vick's series (*Brit. M. J.*, 2:546, 1932) of 6,892 cases these conditions accounted for no less than 94 per cent of the total.

TABLE 3

INCIDENCE OF VARIOUS TYPES OF ORGANIC OBSTRUCTION

(Based on Vick's 6,892 cases)

Simple Obstructions			Strangulations		
	No. of Cases	Percent- age of total		No. of Cases	Percent- age of total
1. Intussusception ..	1034	15.0	1. Strangulated inguinal hernia..	1378	20.0
2. Carcinoma ..	895	13.0	2. Strangulated femoral hernia....	1348	19.5
3. Adhesions	505	7.35	3. Strangulated umbilical hernia..	371	5.4
4. Gall stones	47	0.7	4. Other herniæ .	170	2.5
5. Congenital atresias, etc.	40	0.6	5. Internal strangulation	790	11.4
6. External compression	29	0.4	6. Volvulus	176	2.6
7. Stricture	36	0.5	7. Embolism and thrombosis ...	49	0.7
TOTAL .	2,610	37.9	TOTAL	4,282	62.1

Some statistics show the death-rate in acute obstruction to be as low as 35 per cent, while in others it is as high as 60 per cent. It would, nevertheless, be fair to assess the present-day total mortality

of this disease at about 40 per cent. The mortality of the main types of acute obstruction is detailed in table 4.

TABLE 4

MORTALITY OF THE MAIN TYPES OF ACUTE INTESTINAL OBSTRUCTION

Disease	Approximate Mortality Per Cent
Gallstone obturation	50-60
Carcinoma of the colon	35-40
Adhesions	30-35
Internal strangulation	30-35
Volvulus	50-55
Intussusception	15-20
Strangulated inguinal hernia	10-15
Strangulated femoral hernia	15-20
Strangulated umbilical hernia	30-40

TYPES AND CAUSES

(A) **Simple Obstruction.** Acute intestinal obstruction in its simplest form consists of a single interruption of the lumen of the bowel. This may be due to:

1. Impaction in the lumen of a solid body, *e.g.*, concretion of faeces or barium, large gall-stone, foreign body, etc.
2. Disease of the wall of the gut, *e.g.*, neoplasm, stenosis due to chronic inflammatory conditions, etc.
3. Extrinsic causes, *e.g.*, adhesion, band, pressure from without by tumours, etc.

Mechanical disarrangement of the bowel wall, *e.g.*, intussusception.

There are two main types of simple obstruction: (1) high small-cut obstruction, characterised by profuse vomiting and loss of fluids, and (2) low small-gut obstruction, marked by progressive intestinal distension which causes severe local effects in the obstructed bowel.

High Small-Gut Obstruction. Here the duodenum or jejunum is occluded and the vital digestive juices are prevented from reaching the highly absorptive bed of the ileum. Some 5 to 7 litres of digestive

secretions from the stomach, pancreas, liver and duodenum are poured out daily into the stomach and upper intestine, and this valuable fluid which is the source of the blood plasma is lost by vomiting and by the absence of absorption. This rapid loss of fluid and electrolytes and the associated dehydration is the cause of death in high obstruction.

The main clinical features are sharp colicky upper abdominal pains, profuse vomiting, marked dehydration, and early and fatal collapse.

Vomiting is copious from the start. At an early stage the material vomited consists of semi-digested food and opalescent gastric chyme. Later on, watery fluid laden with bile is voided in large amounts, and finally a stage is reached when the vomitus is composed of dark brown, evil-smelling fluid—fæculent vomiting. Fæculent vomiting is always an accompaniment of obstruction of the small intestine; it is only very rarely observed in cases of obstruction of the colon. It has to be distinguished from true fæcal vomiting which occurs only in cases of gastro-colic fistula.

Dehydration is the most obvious of the physiological changes, and its effect on the tissues and on the blood is evidenced by the dry, shrunken skin, the sunken eyes, the extreme thirst, the hoarse voice, and the scantiness of the urine passed. The deadly effect of dehydration was well shown by Hartwell and Hoguet (*J. Am. M. Ass.*, 59:82, 1912) who for several weeks prolonged life in dogs with high intestinal obstruction by introducing large quantities of saline solution subcutaneously. Control animals not so treated died in a few days. Armour (quoted by Wilkie, *Brit. M. J.*, 2:543, 1932) kept dogs with high small-gut obstruction alive for about five weeks by introducing fluids into the intestine below the experimental block, thus proving the lethal effect of the loss of absorption. Haden and Orr (*J. Exper. M.*, 37:365, 1923) were among the early research workers to demonstrate a fall in the blood chlorides in experimental high obstruction, and Gamble and McIver (*J. Exper. M.*, 48:849, 1928) showed a loss of other ions besides chlorine, namely, sodium and bicarbonate, and proved that this fall in essential plasma salts could only be explained by the loss of the digestive secretions of the stomach, pancreas, liver and intestine. In the later stages of high small-gut obstruction, alkalosis is present, also the plasma protein rises from the normal 7 per

cent to 10 to 11 per cent, and there is an increase in the blood urea and a rise in the total non-protein nitrogen of the blood.

In high small-gut obstruction the removal of the accumulating fluids in the stomach and upper reaches of the small intestine by siphonage and the intravenous administration of water, salts and glucose in measured quantities, form the basis of sound therapy.

Low Small-Gut Obstruction. The ileus, or to be more precise the distal ileum, is the commonest site of intestinal obstruction. It is this portion of the gut which so often becomes ensnared by adhesions and inflammatory or congenital bands; trapped at the internal or external ring of an inguinal hernia or by the razor-like edge of Gimbernat's ligament; paralysed from immersion in foul peritoneal exudates; or blocked by a migrant barrel-shaped gall-stone. In many respects the same processes are at work as in high small-gut obstruction, but the results are modified by the enormous length of the obstructed segment and by the fact that a part of it is resorptive in character.

Holt writes:

If reabsorption were complete, the signs and symptoms of obstruction would be absent; but usually absorption is incomplete, and a slowly progressive distension develops. The capillary and venous circulation is interfered with, giving the gut a congested appearance; there are submucous hæmorrhages; and patches of necrosis are found in the mucosa, especially on the anti mesenteric border. The intestinal wall becomes thickened by plasma exudate from the capillaries, and from the same source comes the plasma-like peritoneal fluid. The intestinal muscle, perhaps as the result of over-stretching or œdema, loses its tone and contractile power, tending to produce a partial or complete paralysis of the gut immediately above the obstruction. In such a way are produced the heavy, thick-walled, distended, and congested loops of small intestine so often seen at operation.¹

In low small-gut obstruction vomiting is not such a prominent feature as is the case with lesions involving the jejunum. Dehydration, too, is a more tardy process. Toxæmia has long been thought to be the cause of death in most of the cases of low obstruction, but recent research has proved that infection and dehydration, and in some cases, notably large strangulations, even hæmorrhage is responsible for most of the fatalities.

Large-Gut Obstruction. In large-gut obstruction the acute stage is

¹ Holt, *Lancet*, 2 62, 1939.

never so claimant as it is in small-gut obstruction, partly because the colon has time to adapt itself to the stasis and partly because the blockage is seldom of a permanent nature and is rarely complete.

Dehydration and blood changes are never permanent, and although extreme distension may occur, the colon appears to tolerate it far better than does the ileum. The danger of sudden decompression is also present in a lesser degree. In spite of these favourable conditions the mortality of major operations for acute colonic obstruction is extremely high. The explanation lies in a lowering of the patient's resistance by the previous debilitating illness. If this is kept in mind, and the more radical procedures avoided, there is a fair prospect of tiding the patient over the acute attack, and thus converting the case back to a chronic obstruction (Cokkinis).

It is not generally recognised that acute obstruction of the colon by a stenosing carcinoma is an example of the closed-loop type of obstruction. Mackey writes on this point as follows:

In many of these cases the ileo-cæcal valve is so patent that no regurgitation is possible, the large bowel proximal to the stricture becoming essentially a closed loop which is progressively distended by a constant addition of ileal content. This type of obstruction, being a very common and very fatal one, merits special consideration. Since there is no stagnation of small-bowel content until the latest stages, vomiting is rare, and this negative feature is often the cause of dangerous delay in diagnosis. The colon is progressively distended and its wall is subject to steadily increasing tension. This tension is proportional to the circumference of the tube and so is greatest in the cæcum. It is, therefore, the cæcum which distends to the greatest extent, which is first the seat of so-called stercoral ulceration, and which, in the unrelieved case, ruptures. The march of events is slow, however, because in the majority of cases the obstruction is in the distal colon, the obstructed loop is of great capacity and of considerable resorptive power.²

(B) Closed-Loop Obstruction. In this type the loop is closed at both ends so that there can be no escape of the gaseous and fluid contents of the entrapped segment of gut.

Within the loop there accumulate, in addition to fluids already present, the secretions of the obstructed loop and inflammatory exudate, in which both aerobic and anaerobic organisms multiply. Pressure within the loop readily attains a level which impairs the capillary circulation, and ulceration of the mucosa, infection and gangrene of the wall, rupture and peritonitis follow. At this stage death is almost inevitable. The classic example of closed-loop ob-

² Mackey, *Med. Press & Circ.*, 202 297, 1939.

suction is, of course, acute obstructive appendicitis in which at the base of the appendix the lumen is closed by a faecal concretion. A more apt example is the type of obstruction which occurs when a loop of small bowel slips through a hole in the mesentery or behind a congenital intra-peritoneal band, either of which conditions closes the lumen at two points.... It will often have been noted that in cases of low obstruction of the small bowel, the lethal factor is progressive increase in hydrostatic pressure in the obstructed loop. In closed loop obstructions this factor operates in a more obvious and often more readily fatal manner.*

(C) **Bowel Obstruction with Strangulation.** The morbid anatomy of strangulated external abdominal hernia is discussed on page 1017.

(D) **Paralytic Ileus.** In paralytic ileus the gut wall is not truly paralysed but rather its activity appears to be inhibited by an over-active sympathetic nervous system. Although there are many causes of the condition, by far the commonest are peritonitis and intestinal obstruction. A painless progressive distension of the abdomen is produced, and this in the later stages is associated with vomiting and circulatory failure.

The subject has already been considered under the title of peritonitis (page 913), but further reference to it will be made when discussing the post-operative management of cases of acute intestinal obstruction.

DIAGNOSIS

The chances of a successful issue in a patient with acute intestinal obstruction are almost wholly dependent upon early and accurate diagnosis. The importance of the time-factor has already been emphasised, and this is confirmed by all statistics. Every anatomical and physiological change associated with obstruction is cumulative in character. Success in treatment frequently depends upon a correct determination of the precise manner in which the bowel is obstructed.

Accurate clinical diagnosis involves the following:

1. The discovery of the *presence* of acute intestinal obstruction.
2. Recognition of the *type* and *level* of the obstruction; and
3. A diagnosis of the *cause* of the obstruction.

The Discovery of the Presence of Acute Intestinal Obstruction. Is the bowel obstructed? There are three common complaints of pa-

* Mackay, *Loc. cit.*

tients with obstruction: (a) pain; (b) vomiting; and (c) distension. The pain, like that of other abdominal colics, is cramp-like and intermittent; vomiting is often frequent and copious, and when the patient is examined some distension is usually present.

SYMPTOMS

The *pain* is ushered in abruptly. It is colicky in nature like "gas" pain, and usually lasts from one to three minutes. It increases in intensity, often to an agonising seizure, and ceases as abruptly as it began, only to recur again and again and at times rhythmically. In the intervals between the bouts of colic the patient may experience complete relief, or there may be the dull and tiresome ache so characteristic of intestinal distension. Transudation of blood and fluid into the general peritoneal cavity, as occurs in strangulating obstructions, produces a more continuous type of pain and also gives rise to tenderness on abdominal examination. It must be remembered that intestinal colic is always present in cases of intestinal obstruction of mechanical origin. Late in the course of obstruction the paroxysmal pain diminishes owing to distension and paralysis of the bowel.

Synchronous with the pain it is often possible to hear borborygmi, and on auscultation loud splashing, rushing, gurgling or tinkling sounds may be made out, these being intensified over the site of the obstruction itself. If the bowel is markedly distended with gas these sounds have a peculiar metallic or bell-like character; on the other hand, if there is a considerable quantity of fluid in the distended loops, blatant bubbling gurgling noises will be heard through the stethoscope.

Vomiting, which is one of the cardinal symptoms of obstruction, is of two types: (a) reflex vomiting, such as may accompany any acute abdominal disorder; and (b) persistent regurgitant vomiting. Reflex vomiting may occur at the onset of any case of obstruction, but is, as a rule, not repeated. Cases of large-gut obstruction may proceed to a fatal issue without vomiting during any stage of the malady. Intestinal colic attended by marked distension of the abdomen without vomiting is usually due to obstruction of the colon. Regurgitant vomiting, which fails to relieve pain, is characteristic of small-gut obstruction. The higher the level of the block in the bowel, the

more copious the vomiting; and the more turbid and fæculent the vomitus, the more grave the prognosis.

As previously stated, the vomiting of fæces—fæcal vomiting—never occurs in obstruction. It is therefore more correct to describe the regurgitation of the foul malodorous contents of the distended small gut as fæculent vomiting. This is a grave omen, in fact a sign of impending death. It is only on the rarest of occasions that the life of the patient can be saved when vomiting of this nature is present.

Absolute constipation, neither flatus nor fæces being passed, is a late and unreliable symptom of obstruction. A patient may be constipated for a week or more and yet suffer from no signs or symptoms of obstruction; another patient with an urgently strangulated loop of small gut may have had a free action of the bowels some hours previously. In Richter's hernia and in intussusception there may be normal bowel movements; again, in acute obstruction of the left colon due to a stenosing carcinoma, an enema may wash out the contents of the gut distal to the stoppage; while in other cases the stimulus of sudden occlusion may spontaneously empty the intestine distal to it. It is the usual practice to administer an enema or to give two diagnostic enemata to determine whether the patient is capable of passing flatus or fæces. If no flatus is passed, even after the administration of the second enema, it is usually assumed that complete intestinal obstruction is present. Yet in practice I have at times found this test to be misleading, and too much reliance should thus not be placed upon it. Acute obstruction must be diagnosed within a few hours of its onset and the surgeon should not wait for constipation to become absolute. If a patient has recurrent intestinal spasms and is unable to pass wind, obstruction is almost certainly present. Colicky pain in the absence of obstruction is always accompanied by the passage of flatus.

SIGNS

In the early stages of acute intestinal obstruction the temperature, pulse and respiration, and blood pressure are usually normal or only very slightly raised, and the patient's appearance does not, as a rule, suggest the presence of a potentially serious malady. At a late stage in obstruction, owing to dehydration and toxæmia, the characteristic

sunken features, anxious expression, pallid skin, feeble pulse, falling temperature and cold extremities will be observed. In Wangersteen's well-chosen words:

A composed face affords the examiner considerable reassurance. Still, behind the mask of a Stoic mien much may be hidden. The agony of the patient with severe abdominal pain is usually evident upon his face. The wrinkled and furrowed brow, tense features, and drawn lips which may conceal clenched teeth, speak as plainly as an inner voice. A pallid face with beads of perspiration lend involuntary confirmation of the patient's distress. Periodical tranquil relaxation informs the examiner that the pain is intermittent and colicky in nature.⁴

In strangulating obstructions shock is present, the pulse-rate is often rapid, and the abdominal pain and tenderness which accompany these lesions is much more distressing than in simple obstructions.

Soon after the onset of small-gut obstruction the abdomen will be found on examination to be soft and flaccid, tenderness and rigidity being conspicuously absent. The degree of distension depends upon the site of the blockage and upon the "time factor." Thus, in an established case, when the proximal jejunum is occluded the stomach distends with gas and accumulated secretions and the epigastric region becomes prominent and tense. When the ileum is involved, the central portion of the abdomen is moderately blown out, and when the distal colon is blocked there is considerable universal distension of the belly with well-marked bulging in the flanks.

In acute obstruction of the colon, inflation is a rapid process; in simple small-gut obstruction it is relatively slow in onset; in volvulus of the sigmoid it is quick and may assume stupendous proportions, while in paralytic ileus it is relentlessly progressive in its course. Considerable distension of the intestine may, however, at times be present without any obvious bloating of the abdomen. Inspection may reveal distended coils of intestine or visible peristalsis, but neither of these signs is of itself pathognomonic of obstruction, as either may on occasion be observed in a normal individual who has an exceptionally thin abdominal wall. Nevertheless, visible peristalsis associated with colicky pain at once suggests the presence

⁴ Wangersteen, *The Therapeutic Problem of Bowel Obstruction*, 1937. Courtesy of Charles C Thomas Co.

of an obstructive lesion of the gut. The palpating fingers may detect localised distension or writhing coils of intestine when these do not appear on inspection; or they may, in their search for a cause of the obstruction, discover a mass or a tumour. In left-sided colonic obstruction the tubular gas-filled large intestine and the tightly distended cæcum can be very readily identified on palpation and percussion.

In all cases the flanks should be percussed for shifting dulness; the hernial orifices should be methodically palpated lest a strangulation be missed; and a rectal examination should be performed as a routine procedure.

Rectal examination enables the surgeon to feel the pelvic viscera and perhaps to find distended loops or tumours of the lower ileum or pelvic colon, to discover local growths and strictures low down in the bowel, and to ascertain if the rectum is ballooned, filled with blood or slime, or firmly impacted with faecal concretions.

ABDOMINAL AUSCULTATION

I have shown how in acute inflammatory abdominal conditions this method of investigation is invaluable. It is even more important in cases of obstruction, both in diagnosing the presence of obstruction and in locating the site of the block.

With the onset of mechanical obstruction, the intestinal sounds become louder and more frequent, being loudest immediately over the site of the obstruction. This turbulence is in sharp contrast with the deathly silence which obtains in cases of paralytic ileus.

X-RAY EXAMINATION

X-ray examination of the abdomen is also of help in investigating cases of intestinal obstruction. It enables the surgeon to determine the degree and the extent of the distension, and the position of the distended segments of bowel. At an early stage in obstructive lesions of the large bowel it may show the cæcum to be blown out with gas; it may also show gas in the colon, ending abruptly at the site of obstruction; or it may reveal gaseous mirrors over fluid levels in obstructions of the small bowel.



FIG 234.—STRAIGHT X-RAY PICTURE SHOWING GAS IN THE INTESTINE (Deity).

Visible gas in distended loops of small intestine in adults is *synonymous with intestinal stasis* (figure 234). The stethoscope is of assistance in distinguishing between stasis of mechanical origin and that of paralytic origin. The films may be made with the patient lying either prone or supine or standing erect. In my opinion the most useful information is obtained when the films are taken with the patient lying supine.

In cases of simple obstruction of the small gut treated by conservative decompression, X-ray films of the abdomen should be taken every twelve hours or so in order that the progress of the case may be closely followed.

RECOGNITION OF THE TYPE AND THE LEVEL OF THE OBSTRUCTION

1. **The Type.** Having diagnosed the presence of acute intestinal obstruction, the next step is to ascertain the type of obstruction present. It is most important to distinguish between simple obstruction and strangulation. Simple obstruction is usually of gradual onset, and there is no evidence of shock for some days. The pulse is slow, the temperature normal, and the blood pressure is relatively unaffected until a late stage in the disease has been reached. There are no abdominal tenderness and rigidity, and the whole course of the disease is slow, in fact the patient may appear to be in fair condition for a few days. In strangulation, on the other hand, the onset is sudden and is ushered in with severe pain and shock. The pulse is rapid and the temperature elevated. The diagnosis of external strangulation is rendered easy by the presence of a tense, tender, irreducible tumour over a hernial orifice, with no impulse on coughing. Internal strangulations occasion considerable difficulty in diagnosis, but a tense loop may sometimes be felt, while on abdominal examination tenderness and rigidity will be encountered owing to blood being poured into the peritoneal cavity. Again, recovery from initial shock is never complete, the blood pressure falls, and the patient looks gravely ill and becomes rapidly worse.

Differentiation will also have to be made between mechanical and paralytic ileus. The main distinguishing features of the latter are: (a) the presence of an adequate cause, *e.g.*, peritonitis, previous operation; (b) the complete absence of paroxysmal colicky abdominal pains; (c) rapid tympanitic distension of the belly; (d) the "silent" abdomen—there is absolute silence of the abdomen when auscultation is done.

2. **The Level.** Determination of the level of obstruction is especially necessary in cases of simple mechanical obstruction. In high small-gut obstruction pain is not a marked feature, but vomiting is profuse and frequent, and the patient, owing to the excessive loss of fluids, rapidly becomes dehydrated. Oliguria, insatiable thirst, a rising blood urea, early collapse, and sunken features may be present, all these being characteristic of an excessive loss of fluids and electrolytes. Distension may be absent in the early stages, but later on it be-

comes limited to the epigastrium, and on abdominal auscultation there is hardly any evidence of increased peristalsis. Flatus and fæces may be passed with or without the aid of enemata.

In low small-gut obstruction the onset is more gradual, and the case pursues a less urgent course. There is severe and frequent colicky pain, and vomiting which is persistent but less profuse than that which accompanies high lesions. Constipation is absolute, peristaltic sounds are loud and explosive, and one or more dilated coils of intestine may be seen or felt. At a later stage the distension spreads to the central portion of the abdomen, while at an even later stage the distended coils take on a ladder or organ-pipe pattern. Dehydration, and blood and renal changes associated with low small-gut obstruction do not appear until a late stage is reached.

ACUTE LARGE-GUT OBSTRUCTION

This, of course, is less urgent than the two preceding types. As a rule there are no vomiting, no shock, and no dehydration. There are absolute constipation and a greater degree of abdominal distension. In early cases the cæcum bears the brunt and becomes ballooned, while at a later stage the whole abdomen and the flanks are blown out. At times a mass or tumour may be felt per abdomen or per rectum. The final picture shows a huge barrel-shaped abdomen, the result of the small intestine becoming loaded with gas and fæces due to incompetency of the ileocæcal valve.

DIAGNOSIS OF THE CAUSE OF OBSTRUCTION

This is the last step in diagnosis and often the most difficult one. It is not always possible to make an accurate diagnosis, although whenever this is possible treatment is considerably simplified. The following is the classification of the causes of obstruction based on the age, the history and the clinical findings:

1. **Congenital Causes:** Imperforate anus or rectum, infantile pyloric stenosis, congenital duodenal atresia, or congenital bands.

2. **In Early Life:** Intussusception, Meckel's diverticulum, strangulated hernia, adhesions or bands (post-operative or post-inflammatory).

3. **In Late Life:** Cancer, strangulated hernia, faecal impaction, diverticulitis, volvulus, gall-stones, adhesions or bands.

4. **With Previous History of Operation or of Inflammation:** Adhesions or bands near the appendix or gall-bladder, in the pelvis or under an abdominal scar; or paralytic ileus.

5. **Cases with Special Symptoms and Signs:** Strangulated hernia, intussusception, carcinoma of the colon, gall-stone ileus, volvulus, mesenteric embolism and thrombosis, or pelvic ileus.

These individual causes of obstruction and their diagnosis are discussed in some detail in Chapter 5 of this part.

TREATMENT

The remedial agents which have proved of the greatest value in the treatment of bowel obstruction are: (1) saline solution; (2) blood transfusion; (3) conservative decompression, and (4) operation.

An attempt will be made to assess the therapeutic value of these agents and to indicate when they may best be employed.

This section deals only with *general principles and procedures*; the medical or surgical measures of more specific application will be described under the individual obstructive lesions.

Treatment of High Small-Gut Obstruction

In the majority of cases the treatment of this type of obstruction will be of a purely conservative nature, as the stoppage is usually temporary and the risk of strangulation is slight. Such conditions as acute dilatation of the stomach, pyloric stenosis due to œdema and spasm around a cicatrising duodenal ulcer, and the swelling of a gastro-enteric stoma as may occur after some cases of gastro-jejunostomy, usually show rapid improvement under the measures about to be outlined. Even when operation is clearly indicated, *e.g.*, in mechanical obstruction of the proximal jejunum due to a neoplastic tumour, conservative treatment should be instituted to correct dehydration and to restore normal renal function. The two most important therapeutic agents in the treatment of this type of obstruction are saline solutions given intravenously and conservative decompression.

1. **Saline Solution.** This acts almost as a specific in high small-gut obstruction. The solutions usually employed are: (a) Ringer's solution; (b) Hartmann's solution (it is often advisable to add 4 to 5 per cent solution of glucose to either of the above); (c) glucose-saline solution. A useful preparation consists of 4 per cent glucose plus 0.18 per cent sodium chloride (one part of normal saline to four parts of 5 per cent glucose in distilled water). This solution is isotonic and is given intravenously as a continuous drip at the rate of 3,000 to 4,000 ccm. daily. This supplied 120 gms. of glucose and 5.4 gms. of sodium chloride (Jones and Naunton Morgan, *Lancet*, 2:611, 1939). It is essential to record the fluid intake and loss so that the fluid balance can be assessed at a glance, and enough solution should be given to ensure a daily urine output of 700 to 1,000 ccm. It is also important to regulate the drip and to make sure that the solution is run into the vein at an even rate. Intravenous saline solution is, as before stated, a valuable therapeutic agent.

Much has been learned during the last six years about the normal water and electrolyte balance of the body, and its application in pre- and post-operative cases is due largely to the work of Collier and Maddock (*Internat. Clin.*, 3:191, 1934; *Ann. Surg.*, 102:947, 1935, and 108:769, 1938; and *J. Am. M. Ass.*, 108:1, 1937), who indicated the quantity of fluids required by patients in these periods and also for the control of dehydration in high intestinal obstruction. The reader is also referred to Peters' monograph *Body Water* (1935), and to the excellent contribution of McIver and Gamble (*J. Am. M. Ass.*, 91:1589, 1928) and to the recent paper by Elkington, Gilmour and Wolfe (*Ann. Surg.*, 110:1050, 1939), *The Control of Water and Electrolyte Balance in Surgical Patients*.

2. **Conservative Decompression—Suction Drainage.** Ward (*J. Am. M. Ass.*, 84:1114, 1925) was the first to employ continuous suction to the indwelling duodenal tube in the treatment of peritonitis, while Wangensteen (*Tr. West. Surg. Ass.*, 1931; and *Arch. Surg.*, 26:933, 1933) was the first to employ conservative decompression in the treatment of some types of mechanical obstruction of the small intestine. The popularisation and perfection of this therapeutic procedure is due largely to the work of Wangensteen and Paine (*J. Am. M. Ass.*, 101:1532, 1933). These authors have shown that when the blockage is caused by adhesions and is intensified by the accompany-

ing distension it may be relieved by suction applied to an indwelling duodenal tube. They showed, moreover, that drainage of the distended stomach and intestine above the occluded site renders operation, should this step eventually prove to be necessary, less dangerous and easier to perform.

However, there are a good many patients in whom gastro-duodenal suction is not successful in relieving the distension. Furthermore, even though the distension is relieved by the duodenal suction, the location and nature of the lesion may still be unknown. It is in these cases that the intestinal intubation method of Miller and Abbott (*Am. J. M. Sc.*, 66:961, 1938) may achieve gratifying results. In principle, the method consists of passing through the nose (or mouth) into the small intestinal tract a double-lumen tube or a pair of tubes, the larger opening being used for aspiration purposes and the smaller one for the inflation of a rubber balloon which surrounds its distal end. With the combination of aspiration of the intestinal contents and of inflation of the balloon, peristalsis carries the tube down the intestinal tract. This takes place whether the obstruction is mechanical or paralytic.⁵

Striking results following the use of this method in patients with distension due to several causes have been reported by Abbott and Johnston (*Surg., Gynec. & Obst.*, 66:69, 1938), Golden (*Am. J. Roentgenol.*, 35:316, 1936), Weltz (*Lehrbuch der Röntgendiagnostik*, 1939) and Boon (*Lancet*, 1:7, 1940).

In the treatment of obstruction, this method has been increasingly used and is now fully established as a valuable and often crucial therapeutic procedure in cases of obstruction in which there is no progressive intestinal necrosis that demands immediate operation. The procedure not only permits decompression of the distended bowel, the restoration of body fluids and electrolytes to normal levels by the oral route, and the establishment of drainage from a point immediately proximal to the destruction, but also it has often made it possible, by the injection of a relatively small amount of barium, to define the obstructing lesion and to decide at leisure on subsequent therapeutic measures.⁶

Treatment of Simple Low Small-Gut Obstruction

The distal quarter of the ileum is the commonest site of acute obstruction and the treatment is here governed by the frequency with which strangulation occurs. If recent post-operative cases (para-

⁵ Blalock, *Surg., Gynec. & Obst.*, 68:842, 1939.

⁶ Boon, *Lancet*, 1:7, 1940.

lytic ileus) be excluded, approximately two-thirds of ileal obstructions are associated with external or internal strangulations. Unless therefore the surgeon can be positive that the obstruction is simple in character he should treat the case as one of strangulation; in other words, by immediate operation. In those cases in which strangulation can confidently be excluded by clinical methods, a short trial with non-operative therapy should be instituted before resorting to laparotomy. Conservative measures include decompression of the distended intestines by suction applied to a duodenal or Miller-Abbott tube, and the intravenous administration of glucose-saline solution in sufficient quantity to replace the fluid and plasma salts lost by suction, by vomiting and by non-absorption.

According to Wangenstein, in a mechanical obstruction of the small gut, the signs of successful decompression include:

1. Cessation of gas pains.
2. Decrease of distension.
3. The visualisation of gas in the colon on the X-ray film in complete obstructions, indicating that the obstruction has been overcome.
4. Less fluid aspirated through the duodenal tube, denoting that stasis is no longer prominent.
5. Tolerant of temporary discontinuance of suction without recurrence of pain.

In all mechanical obstructions treated by conservative decompression it is most important to take an X-ray picture of the abdomen every twelve hours or so in order to ascertain that the calibre of the distended gut is actually becoming smaller. If suction-siphonage fails to relieve the obstruction, operation, of course, becomes imperative. What should be done at operation depends upon two important contingencies.

(1) the condition of the patient, and (2) the condition of the intestine.

When the patient's condition is satisfactory, every effort should be made during laparotomy to find and to deal with the cause of the obstruction. If the intestines are greatly distended, a Witzel's enterostomy should be performed immediately proximal to the site of the obstruction in the bowel, and the intestines should be decompressed very slowly. The indwelling duodenal or Miller-Abbott tube

should be left in situ, and suction continued after operation, whether enterostomy has been carried out or not. In the neglected case, when the patient's condition is desperate and the intestines are inflated to their fullest capacity, the surgeon is well advised to perform a rapid "blind" enterostomy, always provided that strangulation can be definitely excluded.

Treatment of Acute Large-Gut Obstruction

About 90 per cent of large-gut obstructions are simple in character, the commonest causes being cancer, diverticulitis, or faecal impaction. Internal strangulation of the colon is very rare, volvulus of the sigmoid being the chief cause, and in the average case it presents no special difficulties in diagnosis. Lockhart-Mummery (*Brit. M. J.*, 1:405, 1933) considers that the danger of overlooking a strangulation of the colon is not more than 1 per cent. In view of this trivial risk and also of the high death-rate attending major operations for acute colonic obstructions, there can be no doubt that the immediate treatment for this type of case should be conducted on conservative lines. The aim should be to convert the acute obstruction back to a chronic one by adopting the following measures:

1. No fluids or any nourishment are given by mouth.
2. Heat is applied to the abdomen.
3. Morphia, gr. $\frac{1}{6}$, is injected subcutaneously at six to eight hourly intervals to allay pain and induce sleep.
4. Repeated turpentine, ox-gall, glycerine or treacle enemata are ordered.
5. Glucose-saline solution is given intravenously by the drip method to maintain the patient's strength.

Duodenal suction drainage is not employed except perhaps in the late cases when the ileocaecal valve, no longer capable, opens its "flood-gates" to the faecal stream.

When the treatment outlined above fails to bring about relief within forty-eight hours or when the patient is obviously too ill to justify the adoption of even conservative treatment, his only chance of survival lies in the performance of "blind" caecostomy under a local anaesthetic. The danger of exploring the abdomen in the cases under discussion, even when the diagnosis is uncertain, is many times

greater than the danger of leaving a large-gut obstruction untreated. The cæcostomy ensures a rapid and satisfactory decompression of the grossly distended large gut, forestalls perforation of the cæcum, enables the bowel to rid itself of the filthy decomposing contents, and above all permits the œdematous, narrowed lumen to dilate so that intestinal continuity is once again established. Through the cæcostomy tube the colon should be gently irrigated once or twice a day with warm saline solution or crude cod-liver oil, while on alternate days the bowel distal to the site of the obstruction is thoroughly washed out with an enema to ensure that it is empty and clean by the time the second operation is due. When it is apparent that no further improvement can be effected in the patient's general and local condition—and it usually takes about ten days to achieve this object—the causative lesion should be displayed through an ample incision.

Internal Strangulation

This subject is discussed on page 1135, while the treatment of doubtful and non-viable intestine is given on page 1127. Suffice it to repeat here that with strangulating obstructions the patient's only chance of survival lies in early diagnosis and prompt operative intervention.

Operative Treatment

In the treatment of acute intestinal obstruction, the following operations are employed:

1. Exploratory laparotomy for obstructions of uncertain origin.
2. Drainage of the small intestine or cæcum—enterostomy and cæcostomy.
3. Blind cæcostomy for obstructions of known type and origin.

Anæsthetic. There is, as a rule, a choice of two anæsthetics, namely, spinal, and local.

Spinal anæsthesia is ideal because the muscular relaxation afforded permits the surgeon to work with the greatest facility. It should not, however, be employed when the patient is profoundly toxic, when he is bled white, or when the blood pressure is low or rapidly falling. In such cases, and where drainage of the gut is indicated, local anæsthesia is preferable.

Exploratory Laparotomy

Operation should be performed with the primary object of saving life by the simplest procedure consistent with ultimate recovery. It is not always essential to discover the obstructing agent. In the absence of strangulation the most important consideration is the relief of distension, which can quite readily and satisfactorily be accomplished by drainage or decompression of the bowel. In strangulating obstructions the constricting agent must in every instance be sedulously sought for and dealt with at the time of the operation, after which the liberated segment of the gut must be critically inspected to determine whether it is viable, doubtful or non-viable. Acute colonic obstructions, if diagnosed with assurance, should under no circumstances be subjected to the risks of an exploratory laparotomy. But if after a brief trial with palliative treatment, distension cannot be overcome, the operation of choice is a valvular cæcostomy.

In the average case the time taken over the operation is not such an important factor as the care with which it is performed. Speed may be a desirable asset in the late cases, but to be effective it must be combined with gentleness and dexterity. The surgeon should be quick, careful and cautious—never hasty; he should avoid extensive manipulations of the distended and friable intestine, and he should remember that the ultimate issue is determined as much by the procedure adopted as by the manner of its execution.

Where shall we make our incision to “look and see”? When in doubt the abdomen is best explored through a right paramedian para-umbilical incision, one-third of the incision being above and two-thirds below the umbilicus. The incision should be in the first instance small—about $2\frac{1}{2}$ to 3 inches in length; but it can, if necessary, be enlarged upward or downward as the operation proceeds.

The operation is conducted on definite set lines. Through the small incision the peritoneum is picked up and cautiously incised, after which a lighted retractor, such as a Curvite, is inserted and the lateral abdominal wall is lifted upward to permit of the cæcum being inspected and then palpated with the finger. If the cæcum is distended, the obstruction must be in the colon. If the peritoneal exudate is not tinted with blood, the laparotomy wound should be closed and cæcostomy performed through a separate small right

gridiron incision. If the cæcum is collapsed, the obstruction must be in the small intestine, where a search for the obstructing agent should accordingly be made. The incision is enlarged and the hernial orifices are palpated from within the abdomen for the possible presence of a strangulated hernia. If a loop of distended intestine can be seen or can be traced with the fingers, passing directly into a hernial orifice, the abdominal wound should be temporarily packed off with large moist swabs and the hernia exposed and dealt with by an incision made directly over it. If the hernial sites are clear, the surgeon should pick up the last loop of ileum, and starting precisely at the ileocæcal junction he should run the collapsed gut through his fingers, loop by loop, and after inspecting each loop, return it into the abdomen until eventually it meets the distended bowel. This point, where collapsed gut meets distended gut, marks the site of the blockage, and the actual lesion will thereupon be seen and can, in a number of cases, be dealt with immediately. Where, however, it is considered inadvisable to remove the cause of the obstruction at once, as may be the case in stenosing growths or granulomata of the small bowel associated with marked intestinal distension, the correct procedure is unquestionably the performance of enterostomy by Witzel's method.

Enterostomy

The operation is performed as follows: A distended loop of intestine near the obstruction is brought out through the abdominal wound, emptied by milking with the fingers, and rubber-covered enterostomy clamps are applied at each end. After the application of the clamps, a hypodermic needle is inserted into the lumen of the intestine and aspiration carried out to ensure that the loop is quite empty. The abdominal wound is carefully packed off with protective waterproof squares to guard the subcutaneous tissues and peritoneum from the highly infective contents of the bowel during the operation of enterostomy.

As soon as the thin-walled distended intestine is completely rid of all its contents, it speedily contracts and thickens in a most surprising manner. Drainage is provided by means of a No. 14 French catheter which is buried in a serous tunnel in the gut wall—Witzel's method (see fig. 226). Enterostomies performed by Stamm's tech-

nique or with the aid of a self-retaining catheter such as a de Pezzer are very unsatisfactory and are frequently followed by tiresome faecal fistulae.

By Witzel's method, a No. 14 French catheter is laid on the anti-mesenteric border of the bowel wall and a running suture of fine silk or of No. 00 twenty-day chromic catgut is made to infold the bowel evenly about it over a length of 2 inches. When this is completed, a small puncture, no bigger than the diameter of the catheter, is made with a diathermy or cautery point, the tip of the catheter being introduced through this into the lumen of the bowel. The catheter is stitched to the margins of the little hole in the gut, and the burying suture is then continued over the site and beyond it for a distance of 2 inches. The loop is returned to the abdomen and the tube is brought out through a small stab incision, except, of course, in the case of blind enterostomy when the tube is led out through the lower end of the small abdominal wound. The catheter may be wrapped in omentum, as recommended by C. H. Mayo, and it is customary to anchor the intestine to the parietal peritoneum with a catgut stitch or two above the point where the tube is drawn through the abdominal wall. There must be no soiling during the conduct of the operation, the enfolding suture must be introduced with great precision, and there must be no excessive turning in of the gut wall. The catheter should be placed with its tip pointing upward against the intestinal stream, as near to the obstruction as is possible, and not high up in the jejunum as advised by Bonney (*Brit. M. J.*, 1:583, 1916). It should also be securely fastened to the skin by an encircling stitch and by adhesive tapes to prevent it from being kinked, twisted, flattened out or dragged upon, and its end directed into a bottle at the side of the bed.

In the post-operative period care is taken to keep the lumen of the catheter perfectly clear by the occasional injection of a few ounces of warm saline or cod-liver oil. The catheter should be left in situ until it works loose. This may take a week, ten days or a fortnight, after which time the small serous-lined tunnel will be found to heal rapidly, usually without leakage.

An intestinal fistula is likely to result if too large a catheter or tube or a self-retaining catheter is used, or if the lumen of the gut is too much narrowed by the enfolding suture or sutures.

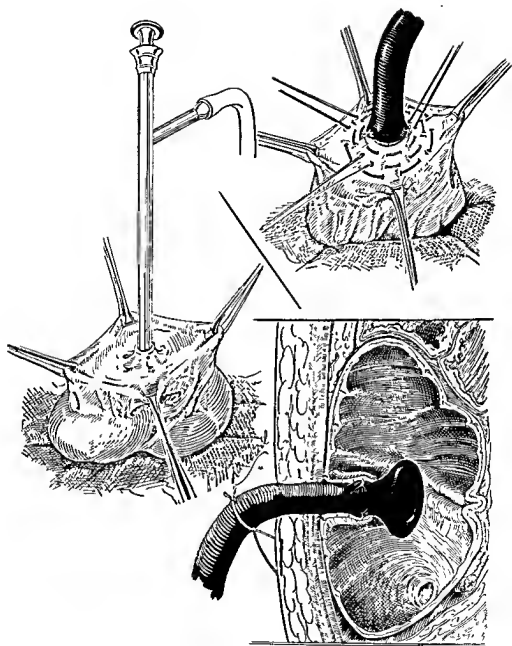


FIG. 235.—CECOSTOMY.

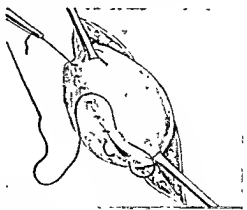
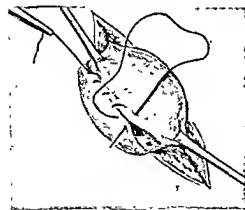
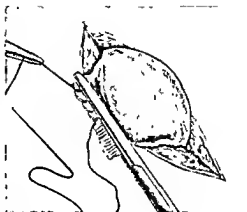
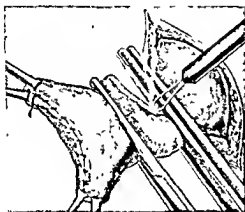
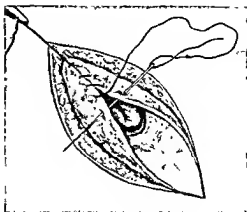
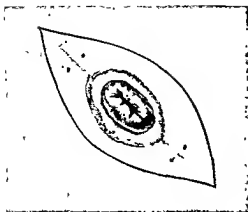


FIG. 236.—CLOSURE OF A CECOSTOMY.
(After Roscoe Graham.)

Cæcostomy

In the operation of blind cæcostomy the distended cæcum is best exposed through a small right McBurney incision. A portion of the cæcum is gently drawn through the incision, great care being taken not to tear the friable gut. The cæcum is then steadied with the fingers while the point of a small trocar and cannula or lumbar puncture needle (connected to a suction apparatus) is inserted into the capacious lumen of the bowel and the pent-up gases are rapidly removed by suction (fig. 235).

As soon as the colonic contents have been withdrawn, the walls of the cæcum collapse and immediately become thicker and more vascular. The cæcum can then be steadied and lifted upward with Allis forceps to enable the assistant to grasp the base of the cæcal cone with his fingers, holding it in much the same manner as an enterostomy clamp. The protruding portion of the cæcum is gripped by these fingers as in a vice, so that it cannot slip backward into the peritoneal cavity. Two or three purse-string sutures of fine silk or No. 00 twenty-day catgut are introduced around the punctured area, which is enlarged with a cautery or diathermy needle to accommodate a medium-sized Winsbury-White tube or a de Pezzer catheter which has had its cone-shaped end cut off. The end of the tube is gripped in the jaws of a hæmostat and pushed into the lumen of the cæcum, the sutures being drawn taut and tied off the moment this is done. This is Stamm's valvular method applied to the cæcum (see fig. 235).

The tube will not get blocked with fæces if it is washed through daily with saline solution and oil, nor will it give rise to a subsequent fæcal fistula when it is withdrawn—usually about the fourteenth post-operative day.

There is no justification for performing cæcostomy by suturing the cæcal wall to the margins of the skin incision. This method has the great disadvantage that the irritating contents of the cæcum constantly leak on to the skin, prolapse of the mucous membrane often develops, and operation for closure of the exteriorised cæcum is ultimately required. The method of closing such a cæcostomy is indicated in the foregoing diagram (fig. 236).

Alternative methods to the cæcostomy described are appendicostomy and Witzel's ileostomy, the point of the catheter being introduced through the gut wall 2 inches from the ileocæcal junction and then led through the ileocæcal valve into the capacious cæcum.

Post-Operative Treatment

It is essential to regard and to treat every case that has been operated upon for acute intestinal obstruction or strangulation as a potential case of paralytic ileus. Warmth, rest and sleep are all very necessary, and the introduction of intravenous or subcutaneous saline solution should be continued until fluids can safely be given by mouth. In the immediate post-operative phase fluids by mouth should only be allowed very sparingly, and in most cases prohibited altogether unless continuous gastric siphonage is being carried out. I make it a rule to withhold all solid or semi-solid nourishment by mouth until the bowels are working normally and regularly. No purges, no enemata, no drugs which normally stimulate peristalsis, are given until the intestines re-awaken to further activity—until, in fact, claimant peristaltic sounds can be heard with a stethoscope.

Inhalation of 95 per cent oxygen, on the lines suggested by Fine, Banks, Sears and Hermanson (*Ann. Surg.*, 107:1, 1935) is indicated in most cases of marked gaseous distension of the intestine. This simple form of therapy may be strikingly successful on occasion.

Finally, a word must be said about adequate vitamin intake. It is well known that the absorption and utilisation of vitamins in patients suffering from gastro-intestinal disturbances are markedly diminished (Vorhaus, *Am. J. Surg.*, 42:350, 1938) and that this may account for sluggish healing of the wound and tardy convalescence. Vitamin C is best given orally, but in those who have been strictly dieted or treated by means of an indwelling duodenal tube for some days, this vitamin should preferably be administered parenterally.

Planned Laparotomy

Operations for individual obstructive lesions are discussed separately in the following chapter.

CHAPTER 5

ACUTE INTESTINAL OBSTRUCTION: THE SPECIAL OBSTRUCTIONS

Many of the special obstructions, such as congenital hypertrophic pyloric stenosis, acute dilatation of the stomach, pyloric stenosis, duodenal ileus, stomal and jejunal obstruction following gastric operations, gall-stone obturation, intestinal obstruction due to tumours and strictures of the jejuno-ileum, strangulated external hernia and paralytic ileus, have already been discussed. Colonic obstruction caused by inflammatory or malignant strictures is considered later on in this part.

This section is devoted to a brief consideration of: (1) acute intussusception; (2) volvulus; (3) mesenteric vascular occlusion; (4) intestinal obstruction due to adhesions and bands, and (5) internal strangulation.

ACUTE INTUSSUSCEPTION

Intussusception consists of the invagination of one part of the intestine into an adjoining part. Except in a few instances, *e.g.*, retrograde intussusception, the invaginated portion enters the distal segment of the gut.

Acute intussusception is the most common abdominal emergency in children under two years of age. Perrin and Lindsay (*Brit. J. Surg.*, 9:46, 1921) investigated 400 cases which were admitted to the wards of the London Hospital between 1903 and 1920, and found that 314 of these, *i.e.*, 78.5 per cent, were under 2 years of age, and that 203 of the total—or about 50 per cent—occurred between the ages of 5 and 9 months. The condition is approximately twice as common in males as it is in females. Among infants intussusception probably results from irregular peristalsis due to enteritis, swollen Peyer's patches, or faulty diet, while in older patients such lesions as a simple pedunculated tumour, a proliferative cancer or an inverted Meckel's diverticulum is generally held to be responsible for the initiation of the condition.

The various ætiological factors concerned in the genesis of intussusception have received detailed consideration from Perrin and Lindsay (1921), Hipsley (*Med. J. Australia*, 2:383, 1918), Wardill (*Brit. J. Surg.*, 13:158, 1925) and FitzWilliams (*Lancet*, 1:628, 1908), and others.

Pathology. A fully-formed intussusception is a slightly curved, sausage-shaped tumour. On section the tumour will be seen to be composed of three concentrically arranged layers, tubes or sheaths. These are : (1) the entering or internal layer; (2) the returning or middle layer, and (3) the ensheathing or outer layer. The entering and returning layers comprise the intussusceptum, and they meet at the apex, *i.e.*, the portion which first becomes invaginated. The ensheathing layer forms the intussusciens, and this joins the middle layer at the neck of the intussusception. As the invagination grows in length, the mesentery is drawn into the intussusception where it becomes compressed between the entering and returning layers on the concave side of the swollen mass. This mass, being anchored toward the middle line by the pull of the mesentery, takes on the characteristic curved shape. On occasion, when the mesentery is unduly lax, the apex may be forced along within the sheath with great rapidity and may reach the anus or even protrude through the anus like a prolapse of the rectum. As a result of the compression of the blood vessels in the mesentery, the apical portion becomes œdematous and choked with blood, producing a swelling which may completely block the lumen of the gut; blood and mucus ooze from the intussusceptum and give rise to the typical "red-currant jelly" stools which are passed; and adhesions quickly form between the tightly opposed serous surfaces of the entering and returning layers. It is these adhesions combined with the swollen imprisoned gut which sometimes make reduction so difficult. Later on, owing to the occlusion of its blood vessels, the invaginated portion of the gut necroses and it is then only a matter of time before perforation and peritonitis supervene. The ensheathing layer, *i.e.*, the intussusciens, is not involved in the gangrenous process, in fact it often acts as a protective cloak. On very rare occasions the whole intussusceptum is passed per anum as a slough, and a spontaneous cure results.

Types. There are three types:

1. *Enteric.* Here the small gut becomes invaginated into the small

gut. This is a rare type, accounting for perhaps about 10 per cent of cases in adults. It is hardly ever encountered in infants.

2. *Colic*. In this type the colon becomes invaginated into the colon. A common cause of this variety is a malignant cauliflower growth of the large gut.

3. *Entero-Colic*. Here the ileum becomes invaginated into the colon. It is the commonest type in infants and accounts for approximately 85 per cent of all cases.

The entero-colic forms of intussusception are sub-divided as follows: (a) ileocæcal, in which the apex is formed by the ileocæcal valve; (b) ileocolic, in which the intussusception originates in the lower ileum and the apex passes through the ileocæcal valve into the colon and may eventually even reach the anus; (c) enteric ileocæcal. Here the ileo-ileal intussusception becomes wedged in the ileocæcal valve, pushes this before it and then proceeds as an ileocæcal intussusception with the valve forming the apex.

According to FitzWilliams, the so-called caput cæci type is an ordinary ileocæcal invagination in which the loose outer wall of the cæcum slips beyond the apex and after reduction shows a well-marked dimple or crater. In many text-books the caput cæci type is simply termed "cæcal." An unusual type of invagination is intussusception of the appendix, of which Huddy (*Brit. J. Surg.*, 14:580, 1926) was able to collect 68 cases from the literature.

Clinical Picture. The outstanding clinical features are paroxysmal attacks of abdominal pain, vomiting, the passage of mucus and blood per rectum, and the presence of a palpable tumour. The patient is often a healthy, fat, chubby child of between 6 and 18 months of age. The onset is sudden, with acute pain, shock and initial vomiting. The pain is of a violent colicky nature, lasts a minute or two, and then after an interval returns and recurs with increasing frequency. At the height of each cramp-like seizure the child may cry out in agony, draw up his knees or assume some grotesque position in his cot. He looks deathly pale and anxious during each attack, and shortly after the onset he vomits a little clear fluid. But at this stage there are no obstructive symptoms, the only striking feature being the recurrent attacks of pain. After a time the symptoms subside and the patient, although listless, blanched and shocked, appears to be somewhat better.

Shortly after the onset, a normal stool may be passed; later, mucus and blood may be evacuated, the so-called "red-currant jelly" stool already mentioned. Tenesmus is usual in the later stages when the apex has reached the sigmoid colon or the rectum.

In advanced cases pain becomes continuous, vomiting copious and the abdomen barrel-shaped, while dehydration and collapse are noticeable features. It should be emphasised that vomiting is not severe at first, but when the obstructive phase begins it then becomes incessant and exhausting. Palpation of the abdomen will reveal little or no distension, tenderness or rigidity if the examination is conducted within twelve hours or so of the initial attack. Marked distension is found in the neglected case.

The fingers should search in some part of the course of the colon for a firm, sausage-shaped tumour, which hardens perceptibly during an attack of colic. If the lump lies under cover of the right lobe of the liver or at the splenic flexure, or if there is considerable distension, it may not be possible to feel it, even with the patient under an anæsthetic. A feeling of emptiness in the right iliac fossa is termed the "signe de Dance." The apex of the intussusception is sometimes palpable on rectal examination, and the examining finger will on withdrawal be found to be covered with blood and mucus.

Differential Diagnosis. When a normally healthy infant screams with recurrent colics, suffers from severe temporary shock, vomits a little, passes blood-stained slime, and presents a soft abdomen with a palpable tumour, the diagnosis is never in doubt. The cases of real difficulty are those in which when the doctor sees the child the attacks of pain have subsided and no lump can be felt even on careful abdominal examination. In such cases, if the history is suggestive and blood and mucus have been passed, an anæsthetic should be given in order to palpate the abdomen for a tumour. If a swelling be felt, the surgeon should have no hesitation in arranging for immediate operation.

The following conditions are likely to be mistaken for intussusception: (1) simple intestinal colic; (2) acute entero-colitis; (3) appendicitis; (4) Henoch's purpura; (5) tuberculous mesenteric glands; (6) rectal polypus and prolapse of the rectum; (7) other causes of intestinal obstruction and of acute peritonitis.

Mortality. The statistics show that the mortality of acute intussusception in infants is about 15 to 20 per cent; thus of the 989 cases

collected by Vick (1932) there was a death-rate of 17.6 per cent. But the mortality in the early cases where a complete and atraumatic reduction has been possible, is very low—possibly not higher than 3 per cent. Success in the treatment of this condition obviously depends upon early recognition and prompt surgical relief, more so perhaps than in any other obstructive lesion, with the possible exception of strangulated hernia. The beneficial results of early diagnosis are reflected in the statistics given by Clubbe, Taylor and Max Page. In Clubbe's series (1921) of 253 operations there was a mortality of 21.3 per cent, but the death-rate in the third 50 consecutive cases was 8 per cent, and in the fourth 50 cases only 3 per cent. Taylor (*Brit. M. J.*, 2:993, 1925) reported 81 operations for acute intussusception with only 3.7 per cent mortality, while Max Page (*Brit. M. J.*, 2:993, 1925) recorded only 9 deaths in 102 operations—a mortality of 8.9 per cent.

TREATMENT

The treatment may be: (1) operative or (2) non-operative. In nearly every case, operation is clearly the treatment of choice.

Technique of Operation. The abdomen is explored through a small paramedian para-umbilical or sub-umbilical paramedian incision. As soon as the peritoneum is opened, two fingers are inserted and the intussusception is reduced as far as possible while it lies in the abdomen. The fingers are made to meet just beyond the apex, and the tumour is gently worked back. The last, most difficult, part of this manoeuvre in the ileocaecal region is best carried out with a loop of gut withdrawn through the wound. This segment of gut will be found to be congested, oedematous and friable, and must in all cases be reduced with great care. It should be wrapped in a swab soaked in hot saline, and cautiously compressed for a minute or two. Reduction should be effected by merely squeezing the distal end of the sheath rather than by pulling on the invaginated portion. After reduction, the gut is inspected, and a tear or a doubtful patch is oversewn with a fine catgut stitch. A discoloured appendix is best left untouched.

The operation is completed by suturing the last three or four inches of the terminal ileum to the medial aspect of the ascending

colon in order to prevent any possibility of recurrence of the intussusception, and I have invariably found that this method is the most effective.

If the intussusception is difficult to reduce, the following methods should be attempted in sequence:

1. Continued firm pressure.
2. Cope's method: The little finger is inserted into the neck of the intussusception, and adhesions binding the entering and returning layers are broken down.
3. Daw's method: Rubber-covered sinus forceps are used to stretch the intussusciens at the neck.
4. Brown's method: The neck is divided with a pair of scissors for an inch or so along its anti-mesenteric border. This is almost sure to release the intussusception, and the cut, which is straightened out, should then be sutured transversely to avoid any narrowing of the lumen of the gut.

If all the above methods have failed to obtain reduction or it is obvious that the invaginated portion of the intestine is frankly gangrenous, the surgeon will be faced with a stern problem as to the correct procedure to adopt. In a number of instances judgment and operative skill decide the issue.

There is a choice of many operations, and no hard-and-fast rules can be followed. The surgeon must obviously decide at the operating table which method will give the patient the best chance of recovery, but all are associated with a very high mortality:

1. The intussusception is left intact, but the margin of the neck is sutured to the entering layer to increase the protection afforded by the sheath. By this method there is a slender chance that the intussusceptum may be cast off as a huge slough.
2. The above method combined with temporary ileostomy.
3. Exteriorisation of the affected segment of gut, combined with temporary ileostomy. (Intestinal fistulæ are not well withstood by infants.)
4. Lateral anastomosis between the loops of bowel immediately above and below the intussusception, leaving the irreducible portion in situ after suturing the margin of the neck to the entering layer.
5. Primary resection followed by side-to-side anastomosis, making a temporary ileostomy above the stoma. This is often the operation

of choice for older children; in infants it is associated with a very high mortality.

6. Mikulicz type of resection.

7. Jessett's operation. This imitates a neutral cure and can as a rule be performed very quickly. The sheath and the entering layer are stitched together at the neck, and the intussusceptum is brought out through a longitudinal incision in the sheath and amputated by degrees, its two layers being simultaneously sutured together. The longitudinal incision is then closed by continuous sutures.

Non-Operative Treatment. If for one reason or another operation is considered inadvisable, an alternative method which sometimes succeeds is to distend the colon with fluid run into the rectum under gravity. Preferably an opaque medium, such as bismuth suspension, should be used and the progress checked with fluoroscopy and by means of serial skiagrams, as advocated by Hipsley (*Brit. M. J.*, 2:717, 1935). With the patient under an anæsthetic, the fluid is run into the colon very slowly with a column of about three feet, the passage of gas or stool suggesting that the reduction has been effectively achieved.

Often the intussusception is reduced quickly except for the last few inches in the ileocecal region. In such cases the process may be completed speedily with little or no shock by operation through a small right gridiron incision.

VOLVULUS

Volvulus, or twisting of the intestine, most commonly occurs in the sigmoid colon, the small intestine or the cæcum. A few cases of volvulus of the transverse colon and of the stomach have been reported. Kallio (*Acta chir. Scandin.*, 70:276, 1932), for instance, has given a good account of 16 cases of volvulus of the transverse colon, while instances of volvulus of the stomach have been recorded by Buchanan (*Brit. J. Surg.*, 18:19, 1930) and by Max Thorek in his book, *Modern Surgical Technic* (1938).

Volvulus is a comparatively rare disease in Great Britain and also in North America, but it is one of the commonest causes of acute intestinal obstruction in Russia and in Scandinavia. Vick, in 1932, collected 176 cases of volvulus occurring over a period of five years

in 21 British hospitals. In his series, volvulus accounted for 2.6 per cent of all obstructions. In most American statistical studies of intestinal obstruction, volvulus would appear to account for some 10 per cent of the total number. Perlmann (*Arch. f. klin. Chir.*, 137:245, 1925), in his study of 215 cases of acute intestinal obstruction, from a Russian surgical clinic, found 111—or more than half—to be due to volvulus. In such countries as Russia, Poland, Finland and Sweden, volvulus of the sigmoid is commoner than volvulus of the small intestine, but the reverse is true in Great Britain and America. Thus, of Vick's 176 cases, 85 occurred in the small gut, 56 in the sigmoid and 35 in the cæcum, while in Sweet's series of 52 cases (*New England J. Med.*, 213:287, 1930) thirty-six (67.9 per cent) occurred in the small intestine, ten (18 per cent) in the sigmoid, and six (11.3 per cent) in the cæcum.

All authorities on this subject stress the significance of the greater length of the intestine and the prevalence of a vegetarian diet amongst Russian and Eastern European peoples as contributory factors to the frequency of occurrence in those countries of volvulus of the sigmoid loop.

The twisting of the intestine occurs around its mesenteric axis, and a closed-loop type of obstruction immediately develops. The vascular changes which arise with such startling rapidity are due to the tight compression of the blood vessels in the mesentery, as also to the rapid and immense distension of the rotated loop of gut. The bowel becomes œdematous and discoloured, and if the obstruction is not promptly relieved, gangrene and perforation supervene, leading to a fatal spreading peritonitis.

In a number of cases, and more especially where a long segment of intestine is implicated, the patient may literally bleed to death, since blood is freely exuded into the gut wall, into the lumen, and into the general peritoneal cavity.

In acute volvulus the onset is sudden, the course rapid (the patient may die within a day or two), and the mortality high—about 50 per cent.

Ætiology. The various ætiological factors may be classified as follows:

1. *Congenital Anomalies:* (a) Unduly long and mobile sigmoid or cæcum (Fernström: *Acta chir. Scandin.*, 61:212, 1926); (b) pseudo-

megacolon and Hirschsprung's disease (Weeks, *Ann. Surg.*, 94:1050, 1929); and (c) faulty rotation of the embryonic gut—volvulus neonatorum (Dott, *Brit. J. Surg.*, 2:251, 1923, and *Brit. M. J.*, 1:230, 1927).

2. *Acquired Factors:* (a) mesenteric and other adhesions which produce narrowing of the base of attachment of a loop of bowel, *e.g.*, sigmoid; (b) fixation of a loop of "free" gut to the parietes, *e.g.*, as may occur after enterostomy; (c) a vegetable diet which may lead to overloading of the sigmoid, and (d) sudden bodily strain, as may result from the trunk being forcibly twisted.

VOLVULUS OF THE SIGMOID COLON

In most cases the upper limb of the loop descends in front of the lower loop, twisting on its mesenteric axis from one half to two turns in an anti-clockwise direction. The loop is instantly distended to its utmost capacity by gas which cannot be absorbed, and in a very short time it becomes cyanotic, water-logged and gangrenous. A great quantity of blood is poured into the interstices of the gut wall, into the lumen of the bowel, and into the peritoneal cavity, the hæmorrhage sometimes being sufficiently extensive to cause a sudden and fatal collapse. Death, however, is usually due to peritonitis from perforation of the closed loop or from rupture of a gangrenous patch of intestine proximal to the twist itself.

Diagnosis. Frequently there is a history of obstinate constipation or of recurrent attacks of colicky pains associated with distension from which recovery has been spontaneous. As previously stated, the onset is of alarming suddenness, with severe cramp-like spasms, nausea, loud borborygmi, shock and complete constipation, *this being* followed by a tremendous tympanitic distension. This rapid inflation is a strikingly characteristic feature of volvulus of the omega loop. The tensely strangulated bowel forcibly bulges out the abdominal wall and may push the diaphragm upward so as to compress the thoracic organs and thus cause respiratory embarrassment. Reflex vomiting may occur after the onset, but the vomiting never becomes persistent or profuse until peritonitis has developed. Tenesmus and the passage of bloody mucus per rectum are not infrequent symptoms. Marked pallor is often observed and is due to shock and to the great

loss of blood. No flatus and fæces are passed after the administration of enemata—the constipation is absolute. A straight X-ray film of the abdomen will often prove of help in diagnosis, as it may show the outline of the gas-filled dilated loop.

The following conditions have to be considered in the differential diagnosis: (1) mesenteric vascular occlusion; (2) internal strangulation; (3) acute hæmorrhagic pancreatitis, and (4) acute diffusing peritonitis.

Treatment. This consists in early operation and the liberation of the strangulated loop of bowel.

If when the abdomen is opened the distension is found to be only moderate and the gut and mesentery appear to be healthy after the untwisting, it is safe to drop the gut back into the abdomen and close the incision. If there is marked distension, the involved coil of bowel should be eviscerated, deflated by puncture and aspiration, and washed in warm saline solution. If it is obviously viable, it should be drained by Witzel's method or by means of a Paul tube. When, however, the intestine fails to show signs of viability, it should be exteriorised and excised by the Mikulicz method. After the loop has been excised, a Paul tube or a suitable large rubber tube should be tied into the proximal limb, the distal limb meanwhile being steadied in a clamp which is strapped to the abdominal wall. The crushing of the spur and the closure of the colostomy opening are undertaken later, in the manner described on page 1087.

If the patient is seen within an hour or two of the onset, a large stomach tube may be inserted per rectum (with the patient in the genupectoral position) and an attempt made to pass the tube into the loop and to deflate it, this manœuvre occasionally proving successful in reducing the volvulus. If, however, it fails, the abdomen should be opened through an ample incision and an effort made to manipulate the tube by sight past the twist. If this is successful, the deflated bowel is replaced into the abdominal cavity, the tube, with its tip well beyond the site of obstruction, being left in situ for three or four days. When the patient has sufficiently recovered, at a second operation the now healthy omega loop can be safely excised by the Mikulicz method.

Following detortion, recurrence of the volvulus is not uncommon. Finsterer, for instance, reported thirteen recurrences among 47 cases

of volvulus of the sigmoid colon for which detortion only had been performed. For recurrent cases, such operations as colopexy, plication of the mesentery and colo-colostomy (the upper limb being anastomosed to the lower limb) have been practised, but they are most uncertain methods and should in my opinion never be undertaken.

There is no doubt that exteriorisation with excision of the greater portion of loop concerned is the method of choice for recurrent cases, and I maintain that this is the method of election also in those cases where the gut is doubtful or non-viable.

The rectal tube method with drainage of the viable distended loop must be regarded as a temporary palliative measure. It helps to tide the patient over the acute emergency, and prepares him for the more rational radical curative extra-peritoneal resection.

VOLVULUS OF THE SMALL INTESTINE

This often follows a previous pathological lesion, such as local peritonitis or tuberculous mesenteric glands, or an abdominal operation, *e.g.*, appendicectomy. While the chief predisposing factor is narrowing or marked distortion of the base of the mesentery by adhesions, it is not unusual at operation to find no definite cause for the volvulus. The loop or loops of intestine generally twist in a clockwise direction. The lower quarter of ileum is the portion of intestine most commonly involved, although at times a large part of the small gut, or indeed the whole of the jejuno-ileum and its mesentery, may undergo rotation.

McKechnie and Priestley (*Am. J. Surg.*, 34:286, 1936), in their review of 37 cases occurring at the Mayo Clinic between 1910 and 1935, have shown that volvulus of the small intestine is a rare disease and that only 3 of the 37 cases showed involvement of the whole small intestine excluding the duodenum.

Diagnosis. The signs and symptoms are those of low small-gut obstruction with strangulation. The distended coils of small intestine may be felt through the abdominal wall and there may also be signs of shifting dullness in the flanks.

The two conditions most frequently mistaken for volvulus of the small intestine are strangulation of an internal hernia and acute perforated appendicitis with general peritonitis. A leucocyte count, a

straight X-ray of the abdomen, and abdominal auscultation will often help to differentiate peritonitis from volvulus.

Treatment. As soon as the peritoneum is opened, the cyanotic, oedematous and dilated loops of small bowel should be eviscerated,

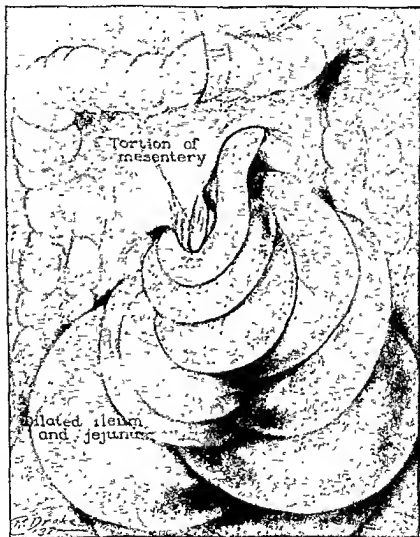


FIG. 237.—VOLVULUS OF THE SMALL INTESTINE.
(Dr. Stalker's case. By courtesy of the Mayo Clinic.)

covered with a warm moist towel, and the mesentery well visualised. Any free fluid in the abdomen (and this is usually straw-coloured in the early mild case, and sanguineous in the more severe strangula-

tions) should at once be aspirated. The involved loop or loops of intestine should then be picked up with both hands and the untwisting carried out with great care and gentleness. When the detortion can be readily accomplished, the involved segment of gut is examined for compression rings, for small areas of necrosis and for signs of viability, and the abdomen then explored for a possible cause of the volvulus, *e.g.*, adhesions, unusual point of fixation of the intestine, long mesentery with short base, etc.

If the gut is viable and if its colour soon returns to normal and if in addition it is not unduly distended and some gas can be observed to pass into the colon, the treatment is clear: the intestines should be replaced in the abdominal cavity and the incision closed. This procedure was carried out with success in Stalker's case (*Proc. Staff Meet. Mayo Clinic*, 14:168, 1939), which is illustrated in figure 237.

If the gut is viable, but the intestine is unduly dilated, enterostomy should be carried out. If gangrene is present or the mesentery cannot be untwisted, resection and immediate anastomosis should be performed, as exteriorisation and drainage of the volvulus is not advised under these circumstances.

VOLVULUS OF THE CÆCUM

Volvulus of the cæcum is usually attributable to congenital abnormalities, such as the presence of a mesocæcum and mesocolon sufficiently mobile to permit of torsion. Rixford (*Ann. Surg.*, 72:114, 1920) states that the cæcum in such cases usually shows a continuation of the mesentery possessed by the terminal ileum, and there may also be a failure of complete rotation of the right colon.

The clinical picture is that of low small-gut obstruction associated with marked distension of the cæcum.

Treatment. When torsion is possible and the gut is viable, recurrence may be prevented by performing cæcopexy or right-sided cæcocolopexy by Waugh's method (*Brit. J. Surg.*, 7:343, 1920). If, after the untwisting, the cæcum and distal ileum are found to be considerably distended, the bowel should be drained on to the surface. Resection is indicated when reduction proves to be impossible or when the involved segment of gut is gangrenous. Resection is a difficult undertaking in such cases and is, of course, associated with a high mor-

tality. Perhaps the wisest procedure and the one accompanied by the lowest death-rate is the Lahey modification of the Mikulicz plan (*Surg., Gynec. & Obst.*, 54:923, 1932).

MESENTERIC VASCULAR OCCLUSION

According to Trotter (*Cambridge Univ. Press*, 143, 1913), this lesion was first identified by Tiedeman in 1843. Virchow (*Arch. f. path. Anat.*, 1:372, 1847) is accredited with the first description of the salient pathological features of mesenteric embolism and thrombosis. The clinical manifestations of this disease were first considered in a paper by Kussmaul and Gerhardt (quoted by Trotter in 1875) and by Litten (*Virchow's Arch. f. path. Anat.*, 63:289, 1875). A large number of cases have been described: Jackson, Porter and Quinby (*J. Am. M. Ass.*, 42:1469, 1904) analysed the records of 214 cases; Trotter (1913) collected 367 cases for his excellent monograph; Meyer (*Ann. Surg.*, 94:88, 1931) investigated 592 cases; while Cokinis, in his classical thesis, *Mesenteric Vascular Occlusion* (1926), was able to draw some valuable conclusions from his study of 92 cases from two British hospitals. Among the most noteworthy contributions to this important subject those of Klein (*Surg., Gynec. & Obst.*, 33:385, 1921), Larson (*Surg., Gynec. & Obst.*, 53:54, 1931), and Boyce and McFetridge (*Internat. Surg. Digest*, 20:67, 1935), should be included.

Some idea of the rarity of the disease may be gained from the realisation that Boyce and McFetridge were able to collect only 13 cases from 30,000 admissions to the New Orleans Charity Hospital over a period of seven and a half years, and 4 of these 13 cases were not recognised until post-mortem examination.

Males are affected more often than females. In Trotter's large series 62 per cent were males and 38 per cent were females, while in Larson's series of 36 cases there were 26 males and 10 females. The majority of the cases occur between the ages of 20 and 60, the peak incidence being around the age of 50. Nevertheless, the disease has been known to affect an infant of one month of age and a patient of 90 years.

Pathology. Mesenteric vascular occlusion is either arterial or venous. Arterial occlusion is in the majority of cases by embolism and

only rarely by primary thrombosis. The source of the emboli is: (1) the heart in endocarditis; (2) the lungs in pyæmia, or (3) the arteries in atheroma.

The superior mesenteric artery is more commonly involved than the vein, the relative frequency being artery 61 per cent and vein 39 per cent. In arterial occlusion the superior mesenteric artery or its branches are affected in 90 per cent of the cases, and the inferior mesenteric artery in 10 per cent.

The effects of embolism vary with its level; with blockage of the main superior mesenteric trunk, the mesenteric circulation fails at once and gangrene is inevitable in the small gut and right colon; but when the embolus lodges in the lower part of the artery, or in one of the intestinal rami, the rich collateral circulation in the mesentery may suffice to keep the gut alive. Unfortunately, the vitality of the gut is ultimately endangered by a secondary peripheral thrombosis, starting from the embolus and spreading into the terminal mesenteric arcades, beyond which no anastomosis exists. Only a timely operation can put a stop to this secondary thrombosis, which is actually the essential morbid factor in most cases, and which, by a lateral spread, devitalises far more intestine than that supplied by the vessel originally blocked.¹

Venous occlusion is always a thrombosis and is secondary either to: (1) portal obstruction due to fibrosis or obliteration or external compression of the portal vein; or (2) peripheral sepsis, *e.g.*, septic thrombosis originating in acute appendicitis, infected hæmorrhoids, etc.

The effects of venous thrombosis are, on the whole, less severe and less extensive than those of arterial blockage, as the process is tardy in its course and there is time for the rich collateral circulation to open up. *The morbid changes in the bowel are classified as anæmic gangrene and hæmorrhagic infarction.* The former, according to Cokkinis, is extremely rare and is caused by the occlusion of arteries previously narrowed by disease. Hæmorrhagic infarction is the usual result of mesenteric occlusion, whether arterial or venous in origin. The intestine at first appears œdematous and congested, then the over-filled capillaries burst and blood is extravasated into the wall of the gut, into the lumen, and into the peritoneal cavity. At an early stage the peritoneal exudate is of a pale amber colour, the intestine

¹ Cokkinis, *Mesenteric Vascular Occlusion*, 1926.

is seen to be water-logged, but the serosa is still glistening, cyanotic, or mottled with purplish spots. Peristalsis is not observed, at least not in that portion of the gut which is involved, and the bowel instead of being distended is often found to be relaxed and somewhat cretated. The mesentery is thickened, doughy and suffused with blood, and on occasion the black thrombosed vessels may be seen or felt as cords. Finally, the gut becomes gangrenous—black, inelastic and friable. The occurrence of infarction is not inevitable, and its spread can be arrested by prompt excision of the infarcted bowel and thrombosed mesentery.

Diagnosis. A study of the collected cases reveals the fact that only on rare occasions has the diagnosis of this condition been made prior to opening of the abdomen or the performance of post-mortem examination. A correct pre-operative diagnosis was made in only 13 of the 367 cases collected by Trotter in 1913. The diagnosis is often quite impossible in what may be termed the slow and deceptive type of case with rueagre symptoms. Jackson, Porter and Quinby, Larson, and recently Donaldson and Sive (*Surg.*, 6.80, 1939) have discussed this variety of mesenteric vascular occlusion in which the disease runs a mild and chronic course for some days before the existence of a grave intra-abdominal lesion is even suspected. This group occurs especially among cases of uræmia, coma, apoplexy, and senile dementia, but is by no means limited to such conditions. Such patients may show collapse with a moderate degree of abdominal distension and vague abdominal pains.

The more usual manifestations of the disease are the sudden onset of severe acute abdominal pain, shock, vomiting and diarrhœa. The stools and vomitus often contain blood. Diarrhœa is a prominent feature, although in some cases there is absolute constipation. Profound shock due to blood loss is generally apparent, and the pulse is very rapid and irregular. The temperature is as a rule normal or sub-normal, but sometimes there is pyrexia, even at an early stage in the disease. Distension of the abdomen is slowly progressive, but is never marked. In some 5 to 10 per cent of the cases a vague doughy abdominal tumour can be made out in the umbilical region, in the hypogastrium or in the left iliac fossa. There may or may not be evidence of the source of the embolism or thrombosis, *e.g.*, endocarditis, appendicitis, etc.

Mesenteric vascular occlusion should be suspected when a patient beyond middle life and giving a history of cardiac trouble is suddenly seized with acute abdominal pain which is, however, not definitely colicky in character, collapses, and passes frequent blood-stained watery stools, and when examination reveals a normal or sub-normal temperature, a rapidly rising pulse-rate, a falling blood pressure, a deathly pallor of the skin such as is seen with profuse internal hæmorrhages and in the worst forms of shock, a leucocytosis, a slowly progressive distension of the abdomen, the presence of generalised abdominal tenderness, but only a suspicion of muscular guarding, free fluid in the peritoneal cavity, and the dilatory advent of paralytic intestinal obstruction.

Treatment. Immediate operation and wide excision of the involved segment of intestine is the treatment advocated.

The enterectomy entails: (1) resection of the infarcted segment together with at least 12 inches of gut proximally and distally; and (2) resection of the thrombosed mesentery together with a margin of healthy mesentery in order to be quite certain that the excision has extended well beyond the limits of the spreading thrombosis. Following the enterectomy, the proximal and distal ends of the intestine should be securely closed, after which a lateral (side-to-side) anastomosis is carried out and the defect in the mesentery closed. Drainage of the peritoneal cavity is unnecessary.

Flint (*Bull. Johns Hopkins Hosp.*, 23:127, 1912), as the result of his experiments upon dogs, evolved a working plan that 50 per cent of the small intestine could be excised without producing any untoward symptoms. Haymond (*Surg., Gynec. & Obst.*, 61:693, 1935) states that a patient can withstand a massive resection of 33 per cent of the length of the small gut with good expectancy that the digestive tract will return to normal function, and that a resection of 50 per cent constitutes the upper limit of safety.

Meyer, however, reported recovery after practically complete removal of the small intestine, Wulsten recovery after removal of 360 cms. of small intestine, and Sjovald after resection of 450 cms. (or 90 per cent) of the small bowel (Clagett and Gray, *Proc. Staff Meet. Mayo Clinic*, 15:41, 1940).

When the main trunk of the superior mesenteric artery is seen at operation to be completely blocked so that the entire jejunum-ileum

and a portion of the colon are involved, the case is obviously hopeless. When a formidable length of small intestine is seen to be gangrenous, the surgeon may despair of saving his patient's life, but his duty is clear: He should resect the infarcted segment, even though such a procedure may entail nothing less than the removal of some 15 feet or more of small intestine.

Instances of spontaneous cure have been reported by Ochsner, Deaver, Jopson and Laws. In a number of these cases the abdomen was opened, the small intestine was found to be dark blue or purple in colour, and after a brief inspection the bowel was returned to the abdomen and the wound closed, recovery following without any further operative interference. In such circumstances the lesion is unquestionably a trivial one—the vascular occlusion was clearly incomplete.

The first successful operation for mesenteric vascular occlusion was performed by Elliot (*Ann. Surg.*, 9:21, 1895). This surgeon exteriorised the gangrenous small intestine and after suturing the abdominal wound around the issuing limbs, the involved segment of bowel was resected. A few days after this operation, when the patient's condition was more favourable, he skilfully re-established the continuity of the bowel.

The operative death-rate is very high. In Cokkinis's series (1926) the total operative mortality was 83 per cent, but of the cases in which resection was performed 50 per cent of the patients recovered. Jackson, Porter and Quinby reported only four recoveries among 47 patients subjected to laparotomy up to 1904. As late as 1921 Klein could find in the literature only 24 patients who had been saved by timely operation, while ten years later Mayer (*Ann. Surg.*, 94:88, 1931) reported 39 recoveries out of a total of 92 recorded operations for this disease. In Boyce and McFetridge's small series (1935) of 10 cases, only one patient survived the ordeal of operation.

INTERNAL STRANGULATION

The two commonest causes of internal strangulation of the intestine are bands and internal apertures.

Bands. There are three varieties of bands:

1. *Peritoneal.* These are strong fibrous peritoneal cords or strands

of varying thickness and length. They are most frequently found at the sites of previous inflammation or beneath operation scars.

2. *Omental*. The free margin of the great omentum becomes fixed to an inflamed structure such as a suppurating mesenteric lymph gland and is subsequently slowly stretched and moulded into a band or cord.

3. *Visceral*. These are formed by an adherent appendix, Meckel's diverticulum, fallopian tube, pedicle of an ovarian or uterine tumour, or even by an attenuated loop of the small intestine itself.

The bands are most frequently seen in the form of arches through which the intestine passes and becomes strangulated. The bands are either attached at both ends or are free, *i.e.*, they are attached at only one end. The latter form snares or knots which trap a loop of gut and strangle it.

Internal Apertures. Holes in the mesentery of the small intestine, mesocolon, mesosigmoid, great omentum, gastrohepatic omentum, falciform ligament or broad ligament are occasionally congenital in origin, but more often they result from trauma, *e.g.*, penetrating wounds of the abdomen or blunt trauma, or from abdominal operations. A loop of intestine slipping through such an aperture is likely to become strangulated by its fibrous margins.

A segment of intestine may likewise enter one of the retroperitoneal fossæ, and in so doing it may become strangulated.

The retroperitoneal fossæ may be classified as follows:

1. *Duodenal*: (a) superior duodenal fossa: to the left of the fourth duodenal segment, facing downward; (b) inferior duodenal fossa: to the left of the fourth, facing upward; (c) para-duodenal: to the left of the fourth duodenal segment, facing forward and to the left; (d) duodeno-jejunal fossa: between the duodeno-jejunal angle and the transverse mesocolon, facing forward; (e) retro-duodenal fossa (infra-duodenal, retro-duodenal inferior): behind the duodeno-jejunal angle, facing downward; (f) posterior duodenal fossa of Gruber (retro-duodenal superior): behind the duodeno-jejunal angle, facing upward.

2. *Mesenterico-parietal fossa*: behind the mesenteric root and below the duodenum, facing to the left.

3. *Meso-colic fossa*: in the mesocolon behind the ascending branch of the left colic artery, facing to the right.

4. *Inter-mesocolon*: in the mesocolon to the left of the middle colic artery, facing to the right.

5. *Ileocaecal fossa*: between the mesentery of the appendix and the ileocaecal "bloodless" fold of Treves.

6. *Retrocaecal fossa*: behind a partially anchored caecum.

7. *Retro-sigmoid fossa*: below the pelvic mesocolon with its sigmoid vessels and in front of the bifurcation of the left common iliac artery.

A detailed account of the embryology, anatomy, etc., of these fossæ will be found in Moynihan's classical work, *On Retro-Peritoneal Hernia* (2nd ed., 1906) and in an interesting contribution by Rendle Short (*Brit. J. Surg.*, 12:456, 1924).

Strangulation may also occur through:

1. Congenital or acquired openings in the diaphragm (Hedblom, *J. Am. M. Ass.*, 85:947, 1925; Keith, *Brit. M. J.*, 2:1297, 1910; and Harrington, *Arch. Surg.*, 16:386, 1929) or pelvic floor (Watson, *Hernia*, 2nd ed., 1938, and Black, *Am. J. Obst. & Gynec.*, 27:837, 1934).

2. *The Obturator Foramen* (Horine, *Ann. Surg.*, 87:776, 1927).

3. *The Foramen of Winslow* (Dewis and Miller, *Surg., Gynec. & Obst.*, 45:95, 1927).

All these openings must be regarded as potential hernial orifices, and sometimes internal herniæ may occur through them without subsequent strangulation.

Once the loop of gut has passed through the band, the cord or the edges of the hole exert a constricting valve-like action and thus prevent the escape of intestinal contents. Distension of the ensnared loop occurs and this draws more intestine into the one-way trap until finally strangulation takes place.

The morbid changes in the strangulated segment of bowel have already been discussed in the foregoing.

Diagnosis. The onset is sudden, the course acute, and the pain severe. There is initial shock with pallor and quickened pulse-rate. There may also be a slight rise in temperature. The patient is gravely ill from the start and becomes rapidly and progressively worse. There is frequently some abdominal tenderness and guarding of the muscles owing to the seepage of blood into the general peritoneal cavity. On occasion the tense strangulated loop of intestine may be clearly made

out by the examining fingers. Symptoms of obstruction are also present, but their intensity will vary according to the level of the stoppage.

An accurate diagnosis of the cause of internal strangulation is rarely possible. The palpation of a tense loop of bowel, the discovery on auscultation of the point of maximum peristaltic noises, a scar on the abdomen (was it not Deaver who said: "Scar on the belly—recurrent colicky pain—obstruction" ?) or the history of some previous abdominal disease may sometimes suggest the site of the strangulation. The value of a straight X-ray picture of the abdomen in the diagnosis of these difficult cases should once again be stressed.

Treatment. Immediate operation is imperative as the strangulated loop readily undergoes necrotic changes.

While the patient is awaiting operation, anti-shock remedies are applied. A blood transfusion is given and the gastric contents are aspirated. The abdomen is explored through a paramedian para-umbilical incision, and the escape of blood-stained fluid at once confirms the presence of a strangulation.

The site of the obstruction is sought for by the method described on page 1143.

The next step in the operation consists in the release of the constricting mechanism. When this is a peritoneal or an omental band or a cord, it should be divided between forceps and excised, after which each end is tied off and where possible covered with peritoneum or adjacent omentum. It should be remembered that an attenuated segment of intestine may act as a constricting agent and may be twisted, stretched and distorted out of all recognition. In such cases the whipcord-like bowel may easily be mistaken for a fibrous band and be divided inadvertently with possibly fatal consequences.

When the intestine is strangulated by an aperture, special care is required to avoid injury to the blood vessels which almost invariably run in its margins. The surgeon should gently stretch the opening with the fingers or with a pair of forceps to free the imprisoned intestine rather than divide the edge blindly with a knife or scissors. In those cases where the obstructed loop is markedly distended, it may be advisable to empty the bowel completely with a large-bore needle connected to an aspirating syringe before attempting reduction.

After the strangulated loop of intestine has been withdrawn, the hole should be closed with a continuous catgut suture, or a detached portion of omentum be used as a plug to prevent recurrence of the internal hernia.

The treatment of the strangulated loop and the post-operative management of the case are described on page 1117.

ADHESIVE OBSTRUCTION

Acute intestinal obstruction caused by adhesions is only on rare occasions complicated by strangulation.

Classification. 1. Congenital adhesions and 2, acquired adhesions: (a) post-operative; (b) inflammatory; (c) traumatic.

Abdominal adhesions are seldom congenital; more often they follow injury or inflammation of the peritoneum. Adhesions giving rise to intestinal obstruction are nearly always preceded by operation or by a local or general peritoneal inflammation.

Adhesive obstruction is one of the commonest types of intestinal obstructions: thus of 368 cases of intestinal obstruction reported by Flesch-Thabesius (*Zentralbl. f. Chir.*, 47:1562, 1920) 162 (44 per cent) were due to adhesive bands; in Guillaume's series (*Presse méd.*, 2:822, 1921) of 400 cases of acute intestinal obstruction no fewer than 125 cases were instances of adhesive obstruction; in McIver's series (1933) of 335 cases, this group accounted for 103 (i.e., about 30 per cent), while Bodenheimer, Casten and Fried (*Tr. Internat. Coll. Surg.*, 3:28, 1940), in their recent analysis of 104 cases of acute intestinal obstruction, found 28 examples (26.9 per cent) of adhesive obstruction.

Individual patients vary in their response to peritoneal injury. Some develop extensive adhesions after a clean abdominal operation or after a comparatively mild peritoneal inflammation, while others survive a severe peritonitis without forming any adhesions at all. Adhesions may be localised or generalised.

Most frequently adhesions are localised and follow a circumscribed inflammation, e.g., appendicitis, salpingitis, tuberculous mesenteric glands, etc., or operative trauma.

In cases of adhesive obstruction following operation, appendicectomy is by far the most frequent cause of subsequent intestinal ob-

struction, and statistics show that in about half of these cases drainage was instituted after the appendix had been removed.

Post-operative adhesions are specially liable to occur after operations upon the uterus and adnexa, the gall-bladder, the large intestine, the stomach and the duodenum. They are particularly likely to form when raw surfaces are left uncovered and also when prolonged drainage has been instituted.

Adhesions are at first soft and fibrinous, lightly binding adjacent coils of intestine to each other or to nearby structures. The fibrinous adhesions are mostly absorbed, but sometimes they organise into fibrous bands or membranes—fibrous adhesions. Local adhesions attach coils of intestine to each other, to an inflamed structure, such as the appendix, to a raw area on the parietes or to the under-surface of an operation wound.

In some cases of tuberculous peritonitis or chronic pyococcal peritonitis adhesions may be generalised. Here the adhesions are short and widespread and many obliterate a part or even the whole of the peritoneal cavity. In such cases as these the mesentery also contracts, dragging the intestines toward the posterior abdominal wall. This general fibrosis is chiefly responsible for chronic adhesive ileus.

It is important to distinguish acute intestinal obstruction caused by adhesions from that due to bands. The former is nearly always a simple obstruction, while the latter is frequently a strangulating obstruction. In adhesive obstruction the gut may be kinked, compressed or flattened; the blockage is at first incomplete, but it tends to become absolute as the effect of the kink or compression is aggravated by distension of the intestine. With relief of the distension (as may result from suction-siphonage) the bowel straightens out and the obstruction may once again become incomplete.

Another way in which adhesions cause obstruction is by anchoring coils of intestine to the abdominal wall or by attaching them to each other, thus distorting their lumen or hindering peristalsis. In some cases the adhesive process is responsible for the formation of a volvulus.

Meckel's diverticulum may give rise to obstruction: (1) by kinking the intestine; (2) by actual compression of the bowel; (3) by effecting a volvulus, or (4) by snaring or strangling the bowel.

Meckel's diverticulum is the commonest abnormality of the small

intestine. Meckel's original anatomical studies of this structure (*Handb. d. path. Anat.*, 1812) still remain the greatest masterpiece on this subject. Attention has been constantly directed to the pathology of Meckel's diverticulum, and the literature on the various pathological accidents which may occur to it or arise from it is indeed overwhelming. Such pathological accidents include: (1) intestinal obstruction; (2) internal strangulation; (3) diverticulitis with or without perforation; (4) chronic inflammation with or without the formation of concretions; (5) neoplasms; (6) intussusception, and (7) peptic ulcer with hæmorrhage or perforation (Dragstedt, *J. Am. M. Ass.*, 101:20, 1933; Greenblatt, Pund and Chaney, *Am. J. Surg.*, 31:28, 1936; and Chestermann, *Brit. J. Surg.*, 23:267, 1935).

One of the most instructive and concise accounts of the surgery of Meckel's diverticulum is given by Barrington-Ward in his book, *The Abdominal Surgery of Children* (page 257, 2nd ed., 1937). His article is profusely illustrated and contains a useful list of references.

Diagnosis. Early post-operative adhesions—fibrinous adhesions—are a well-known cause of acute intestinal obstruction. When symptoms of obstruction arise shortly after abdominal operation, it is, as previously emphasised, often a matter of considerable difficulty to decide whether the blockage is due to mechanical causes or to paralytic ileus. In making a differential diagnosis reliance should be placed on the following: (1) a careful analysis of the symptoms; (2) abdominal auscultation; and (3) skiagrams of the abdomen.

Adhesive obstruction due to late post-operative or post-inflammatory adhesions is rarely of sudden onset. There is commonly a past history of an abdominal operation or of a localised or generalised inflammatory lesion. In the majority of cases there is a story of several attacks of threatened obstruction accompanied by colicky pains, mild distension, vomiting and constipation which were of short duration and which were relieved by purgatives or enemata. The attacks become more frequent and severe in character, until complete stoppage occurs.

The symptoms and signs are those of simple low small-gut obstruction. As I have said, in more than half the cases there is a previous history of appendicectomy, usually with drainage. In 95 per cent the small gut is involved, and in nine-tenths of these cases it is the ileum. Severe colicky pains, nausea, vomiting, central distension of the

TABLE I
EARLY POST-OPERATIVE OBSTRUCTION

	Adhesive ileus	Paralytic ileus
Intestinal colic	Present There are recurrent attacks of colicky pain	Absent There is often a dull ache due to the extreme meteorism
Vomiting	May be profuse	Not a prominent symptom
Abdominal auscultation	Peristaltic noises are heard, and they are most intense over the site of the obstruction	A few feeble intestinal sounds may be heard, but more often than not the abdomen is silent
Skagrams	These may reveal the actual site of the obstruction, or again they may prove that the blockage is not complete	As a rule the entire intestine is markedly dilated with gas and fluid. Extreme meteorism dominates the picture

abdomen (without muscular rigidity or tenderness) and marked increase of peristaltic sounds are the main clinical features. Constipation is present in approximately 50 per cent of the cases. An abdominal scar, perhaps with a small incisional hernia, is frequently present, and peristaltic sounds may be loudest in its vicinity. These features—scar on the belly, recurrent colicky pains, vomiting, slight distension of the abdomen without any evidence of tenderness—often combine to produce an unmistakable clinical picture of adhesive ileus.

The frequency of early diagnosis is proved by Vick's figures which show that of 505 cases of acute adhesive obstruction over 60 per cent were operated upon within forty-eight hours of the onset of the symptoms. Yet, in spite of the ease with which an accurate diagnosis can be made in such cases, the operative death-rate is surprisingly high. In Vick's series it was 33 per cent, in Souttar's series it was 31

per cent, while in the more recent series of Bodenheimer, Casten and Fried, the mortality was as high as 39.3 per cent.

In some cases there is a great tendency to recurrence of acute obstruction, and Wangensteen describes cases which have been operated upon more than twenty times. He himself successfully performed the thirty-first operation upon a patient with obstruction from bands.

Treatment. It is indeed significant that the majority of cases of adhesive ileus follow in the wake of abdominal or pelvic operations. A proportion of these are undoubtedly due to faulty technique or to mismanagement of the case in the immediate post-operative phase. Insecure methods of suturing the abdominal wound, evisceration and chilling of the intestines, rough handling of the viscera or mesenteries, intraperitoneal ligation *en masse*, leaving raw surfaces and ligated pedicles uncovered, the injudicious insertion of drainage tubes in clean cases and the placing of these tubes among coils of intestine, an attempt to drain the pelvic cavity in cases of acute peritonitis, and the introduction of super-heated packs, irritant chemical solutions or greasy or oily substances into the peritoneal cavity, all predispose to the formation of adhesions. Good surgery, therefore, is an important factor to be reckoned with in prophylaxis.

Much, too, can be done during the first few days following abdominal operations to reduce the high incidence of mechanical obstruction by the routine employment of suction-siphonage in those cases in which distension arises early or where it is even to be expected. Wangensteen deserves the greatest credit for being the first to show that a large number of obstructions due to adhesions respond successfully to suction-siphonage, and it is now common knowledge that suction applied to an indwelling duodenal or Miller-Abbott tube will usually afford relief: (1) in partial small-gut obstruction; (2) in all those cases of obstruction which occur as a complication of an accompanying inflammatory process, *e.g.*, appendix abscess, and (3) in adhesive obstructions occurring early after abdominal operations.

When operation is indicated for the relief of adhesive obstruction, the abdomen should be explored through an ample paramedian incision. In a number of cases it is possible to determine by clinical and radiological methods with a fair degree of accuracy the site of the constricting agent. The freeing of the kinked and compressed intestine may on occasion be a very simple matter, merely requiring

the dissection or excision of a solitary fibrous band. In some cases, however, a very prolonged dissection is needed to liberate the adherent coils from one another, from an adjacent viscus, or from an abdominal scar. Sometimes the entangling adhesions are so extensive or a number of coils are so inextricably welded together that a determined attempt to liberate the involved coils may prove fatal to the patient. Moreover, should the patient survive such an attempt, it is almost certain that adhesions will recur, often to an exaggerated degree. In such cases as these, provided distension is not severe, it is wiser to short-circuit the obstruction by performing a lateral anastomosis.

When the bowel is greatly distended, simple drainage—enterostomy—by Witzel's method is the safest procedure. In some cases where a small segment of bowel is hopelessly compromised, resection may offer the only hope of permanent cure. In late cases when the patient is dehydrated and the intestines are much distended, immediate laparotomy directed to the cause of the obstruction is usually a fatal undertaking, and the best chance of saving life lies in the adoption of conservative treatment. Dehydration and collapse should be treated with intravenous glucose-saline solution and blood transfusion, and the inflated intestines should be slowly decompressed by an indwelling duodenal tube. In a number of instances these simple measures will relieve the distension completely and thus overcome the obstruction; in others they diminish the distension and minimise the dangers of subsequent operation.

When the relief afforded is inadequate, the decompression should be completed by performing an enterostomy under a local anæsthetic. This is not entirely a blind enterostomy as the risk of overlooking a strangulation—and an internal strangulation nearly always reveals itself by an escape of sanguineous fluid—is greatly reduced by the small abdominal incision.

Should the enterostomy prove to be the only means of escape of bowel contents and the intestine below continue to be tightly obstructed, a subsequent attack aimed at releasing the obstructing mechanism will have to be conducted. The succeeding procedures will therefore entail either: (1) release of the intestines from the adhesions; (2) entero-anastomosis—to short-circuit the obstruction; or (3) resection of the peccant segment of gut.

CHAPTER 6

DIVERTICULITIS OF THE COLON

Diverticula of the colon are either congenital or acquired. True congenital diverticula or acquired diverticula of the secondary type, i.e., those due to traction of the gut wall, are very rare and are of no particular surgical interest.

This chapter therefore is devoted entirely to the condition of primary acquired multiple diverticula of the colon in which the diverticula are herniations of the mucous membrane through gaps in the muscularis. The presence of uncomplicated diverticula is referred to as diverticulosis. When these diverticula become inflamed, the term diverticulitis is used.

HISTORICAL NOTE

Cruveilhier (*Traite d'anat. et de path.*, 1849) gave the first description of the gross anatomy of diverticula of the large bowel. Virchow (in 1853) investigated the pathology of "Chronic Adhesive Peritonitis" and its relation to the condition which he termed "peridiverticulitis." Sydney Jones (*Trans. Path. Soc. Lond.*, 10:131, 1859) was the first to report a case of diverticulitis complicated by a fistula into the bladder. Edwin Beer (*Am. J. M. Sc.*, 128:136, 1904) wrote the first comprehensive article on the ætiology and pathology of diverticulitis. W. J. Mayo, Wilson and Giffin (*Surg., Gynec. & Obst.*, 5:8, 1907) were the first to describe the details of the operative treatment of diverticulitis, and reported five cases in which a portion of the sigmoid colon was resected for this disease. Little was known about this subject in Great Britain until 1908, when Maxwell Telling of Leeds published the results of his investigations and studies on diverticulitis in a most illuminating contribution (*Lancet*, 1:843, 1908). Following the publication of Telling's paper, further interest was stimulated by the writings of W. J. Mayo, Moynihan and Lockhart-Mummery and by the excellent essay by Hamilton Drum-

mond on the same subject which appeared in the *British Journal of Surgery* in 1916.

The literature on diverticulitis is now truly voluminous, and the student who wishes to acquire a sound knowledge of this disease has access to many valuable papers. His studies, however, would not be complete without reference to the article by Spriggs (*Brit. M. J.*, 2:569, 1929) and to that superb monograph by Harold Edwards, *Diverticula and Diverticulitis of the Intestine* (1939).

ÆTIOLOGY

It is difficult to assess the true incidence of diverticulosis of the colon. Larimore (*J. Missouri M. Ass.*, 22:129, 1925) reported a series of 4,406 X-ray examinations of the colon with the finding of diverticula in 1.25 per cent. Rankin and Brown (*Surg., Gynec. & Obst.*, 50:836, 1930) studied the reports of 24,620 cases which were examined radiologically after a barium enema and found that diverticula were present in 5.6 per cent of these cases. Spriggs and Marxer (*Lancet*, 1:1067, 1927) found the condition to be present in 10 per cent of their patients, while in Edwards' series (1939) of 2,139 patients who were examined by means of a barium enema, diverticula were demonstrated in no fewer than 254 of them, i.e., in 11.87 per cent of the total.

Probably an average incidence of 5% in the cases examined by barium enema will go unchallenged, although we must remember that this does not represent the frequency of occurrence in all patients, but only in those with sufficient symptoms referable to the gastrointestinal tract to warrant special examination. Abell gleaned from a study of the literature a clinical and X-ray incidence varying from 1.7% to 8%. Robertson, reporting from an entirely different source of material, namely a necropsy service, found the condition in 5% of all cases over 40 years of age coming to post-mortem.¹

The condition is slightly more common in males than in females. Thus, in a series reported by Rankin and Brown, 60 per cent of 481 patients were males. Huston (*Arch. Surg.*, 26:1111, 1933) states that the ratio of males to females is 2 to 1. In Spriggs' series of 564 cases, 67 per cent were males.

¹ Rankin and Grimes, *Proc. Interstate Post-Grad. M. Ass. N. Am.*, 1937.

All authors are agreed that males are more frequently affected by the *complications* of the disease than are females.

The average age on onset of diverticulosis is probably between 40 and 45. The majority of cases of diverticulitis are seen between the ages of 50 and 70, the peak age-incidence being 55 to 65. A few cases of diverticula of the colon have been observed in children. Ashurst (*Ann. Surg.*, 47:300, 1908) reported a case in a child aged 7 years, and Ransohoff (*Ann. Surg.*, 58:218, 1913) described the condition in a child aged 3 years.

It is commonly stated that obesity and constipation are predisposing factors, but it is very doubtful whether this statement is correct. Spriggs, in reviewing his 564 cases, concluded that obesity was not commoner in these patients than one would normally expect in a similar series of those in middle life. Rankin says that the impression that fat people are especially prone to develop this disease has been definitely dispelled by careful observers, and they note that the thin are equally affected. Both Spriggs and Rankin conclude that constipation is not of itself a predisposing factor.

It is also alleged that frequent purgation leads to the formation of diverticula of the large bowel. This statement, however, is very difficult to corroborate in view of the large number of people who subject themselves to daily purgation. According to Douthwaite (*Guy's Hosp. Gaz.*, 53:227, 1939) it is quite impossible to dogmatise on the association of septic foci with this bowel complaint. But it may be assumed that there is a conceivable connection and this point should be borne in mind when considering treatment.

It is generally agreed that diverticula of the colon are of the nature of pulsion diverticula, that they result from irregular spasm of the bowel musculature maintained over a long period of time, and that the hernial orifices through which the mucous membrane is forced are provided by the gaps in the musculature through which the blood vessels enter.

Diverticula are most commonly found in the sigmoid colon. The blood vessels enter this segment of the gut at two situations: (1) at the line of attachment of the mesocolon to the bowel wall, and (2) between the site of the mesocolic attachment and the lateral tæniæ coli. Protrusions of the mucous membrane do not occur along the line of the mesocolic attachment because the blood vessels entering

the gut in this position have to pierce the strong posterior longitudinal band which prevents herniation. Diverticula occur at the weakest point in the bowel wall, *i.e.*, along the second line of entering blood vessels.

PATHOLOGICAL FEATURES

The diverticula are always multiple. They may occur in any portion of the large intestine, but they show a preference for the sigmoid colon. Statistics show that in from 75 to 85 per cent of the cases the diverticula are confined to the sigmoid and descending colon. It is interesting to note that in a number of the reported cases the upper portion of the rectum was affected.

There are three stages in the development and progress of the disease:

1. The pre-diverticular stage.
2. The stage of formed diverticula—diverticulosis; and
3. The stage when inflammatory changes have supervened—diverticulitis.

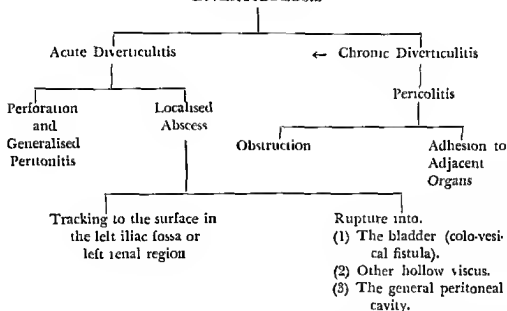
All stages may be present in different parts of the colon or in a segment of it. In the early stages the only naked-eye evidence of diverticulum formation is what may be described as a fine irregularity of the serosa, almost amounting to a series of corrugations which are produced by the bunching together of the circular muscle fibres and the separation of their bundles. At a later stage the affected segment of colon becomes studded with pea-like projections which are clustered beneath the appendices epiploicæ and between the longitudinal bands.

As I have stated, the diverticula are about the size of a pea, but they may be even larger than this, some of the bigger ones having a diameter of nearly half an inch. Each diverticulum consists of a protrusion of the mucous membrane and submucosa into or through the muscularis, and in all but the smaller pouches muscle fibres are present only in the region of the neck of the sac.

The diverticula are in the first instance almost completely globular in outline and their mouths are fairly wide, which allows the semi-solid contents of the colon to enter and leave them freely. It is only when chronic inflammatory changes occur in the wall of the

bowel surrounding the neck of the diverticulum that the latter becomes strictured. When this eventuates, the diverticulum becomes filled with hardened faecal matter and the stage is set for a variety of secondary inflammatory changes which are indicated in the accompanying table.

TABLE I
THE COMPLICATIONS OF DIVERTICULA OF THE COLON
(Edwards)
DIVERTICULOSIS



The pre-diverticular stage is seen in X-ray pictures in approximately 20 per cent of cases of diverticulosis. Diverticulitis demands surgical attention in about one case in ten. There seems to be little doubt that the relationship of carcinoma to diverticulitis is purely incidental.

CLINICAL FEATURES

For convenience these are discussed under the following headings:

1. **Diverticulosis.** It is commonly taught that diverticulosis gives rise to no symptoms at all. This, of course, is not true. Diverticulosis produces symptoms which are mild, amounting to little more than a disordered action of the bowel. There may also be a history of inter-

mittent flatulence, slight abdominal distension relieved by aperients, and of occasional uneasiness or even mild spasm along the course of the colon and more particularly in the left iliac fossa. But genuine pain and the symptoms usually associated with inflammation of a hollow abdominal viscus are conspicuously absent, and signs—apart from the striking radiological ones—are lacking. If pain is a prominent feature and if physical signs are present, a diagnosis of diverticulitis and not of diverticulosis should be made, and treatment carried out accordingly.

I agree that it may be difficult and in some cases impossible to determine by clinical and radiological methods whether or not a mild inflammation is present; but surely the same may be said with equal cogency for certain types of "chronic appendicitis." The matter is really one of academic interest, since the methods of treatment for diverticulosis and for early mild diverticulitis are in every respect identical.

In the more severe cases where the patients are subject to sub-acute exacerbations or have a palpable tender swelling, the issue is never in doubt.

2. Chronic Diverticulitis. In most cases chronic constipation is long standing and severe, although in a few there may be normal bowel movements or a history of diarrhoea from incessant purgation. Bleeding is rare, and occurs in only some 5 per cent of the cases which are investigated.

With the onset of stenosing peri-diverticulitis constipation becomes more obdurate to treatment, and the patient may even exhibit some of the early signs and symptoms of chronic obstruction of the large bowel. A history is sometimes obtained of alternating diarrhoea and constipation, and when this is so it may be difficult to rule out the possibility of a neoplasm. There is often a complaint of heaviness, fullness or soreness in the left side of the abdomen, and more especially low down in the left iliac region; it may, however, be in the epigastrium when the transverse colon is involved or on the right side when the ascending colon is implicated. Vague dyspepsia and flatulence, slight nausea and anorexia may be present. As a rule there is no marked loss of weight, in fact some patients may even gain. At any time during the course of a chronic diverticulitis acute exacerbations may occur, but the outstanding complication is peri-colitis,

leading to obstruction of the bowel or to adhesion to adjacent organs or to the parietes.

3. Acute Diverticulitis. Acute diverticulitis varies considerably in its intensity. In some cases the symptoms are relatively mild, while in others the clinical picture is that of an acute left-sided appendicitis. The patient has all the symptoms of appendicitis, but the signs are referred to the left iliac fossa instead of to the right. In a typical case there are the usual constitutional disturbances, with raised temperature, rigors, quickened pulse-rate, nausea and sickness. Leucocytosis is present. The patient is constipated and complains of a continuous burning pain over the affected segment of gut, this being most frequently situated in the left side of the abdomen.

On examination there is marked tenderness and rigidity in the left iliac fossa, and frequently an ill-defined mass may be made out in the region of the sigmoid or descending colon. Rectal examination usually reveals no abnormality, although the tumour may be felt on the left side of the pelvis if the involved loop is drawn downward by inflammatory adhesions. In the fulminating cases the face is flushed, the tongue furred, the temperature high, the pulse rapid and bounding, and the left half of the belly, and especially the lower quadrant, rigid and extremely tender. The skin over the site of tenderness may be œdematous or reddened with inflammation. In some of these cases the course is so acute that it may be impossible to decide whether a diverticulum has perforated or not.

4. Acute Diverticulitis with Perforation and Peritonitis. This is a comparatively rare complication. In Morley's series (*Liverpool M.-Chir. J.*, 48:67, 1935) of 38 cases of complicated diverticulitis, perforation occurred in six. Perforation may take place while the patient is in bed undergoing strict conservative treatment for acute diverticulitis; or again, it may occur suddenly as the result of some form of strain.

The signs and symptoms are those of a spreading septic peritonitis, and it is therefore not surprising that many of these cases are diagnosed as acute perforated appendicitis.

The history of the case—the patient may have undergone treatment for diverticulitis or be known to be suffering from the condition, the absence of colicky pains before the onset of perforation, and the distribution of the pain—at first more intense in the left iliac fossa

and then rapidly spreading to the hypogastrium and umbilical region, may be elucidating factors in the differential diagnosis.

It is a lethal complication: "and in my experience much more serious than acute appendicitis, as out of 15 patients personally operated upon 7 died within the first week, a mortality of nearly 50 per cent." (McNeill Love: *Clin. J.*, 68:137, 1939.)

5. Acute Diverticulitis with Abscess Formation. This is one of the commonest complications of acute diverticulitis, and in most cases abscess formation is accompanied by an attack of acute diverticulitis. The abscess may rupture into a hollow viscus, such as the bladder, the intestine, etc., and when it does so it partially or completely disperses; it may rupture into the general peritoneal cavity, giving rise to a virulent peritonitis; or it may track to the surface in the left iliac fossa, or may point near the anterior superior iliac spine or in the left renal region where it may resemble a peri-nephric abscess.

6. Diverticulitis with Obstruction. The obstruction is of slow onset, rarely becomes absolute and is usually due to stenosing "peridiverticulitis." The affected segment of gut becomes hard and contracted into a rigid tube, and, as the result of œdema of the mucous membrane, a blockage occurs. In other cases a mass may form and present many of the clinical and even the radiological features of a cancer of the colon.

The following points should be noted:

(a) Carcinomata of the descending colon and sigmoid loop are, as a rule, small, hard, ring-like stenosing neoplasms which are movable, not specially tender on palpation, and show characteristic filling defects on X-ray examination. It is only at an advanced stage that a cancer of this segment of the bowel becomes fixed to the parietes. By the time this occurs there will almost certainly be evidence of metastases, cachexia, pallor and so forth. In carcinoma the stools are often stained with altered blood.

(b) The left-sided mass caused by peri-colitis—diverticulitis with tumefaction—forms a fairly extensive tumour which is tender on deep palpation and soon becomes fastened to the posterior abdominal wall by traction on its mesentery and by the formation of numerous fibrotic bands and membranes. In these cases tests for occult blood are nearly always negative.

(c) A colonic tumor suspected to be of the nature of diverticulitis is unlikely to be so unless the presence of diverticula can be demonstrated radiologically. The narrowing and irregularity in an area of diverticulitis is mostly due to spasm, but with the inexorable spread of the inflammatory process, thickening of the colon and peri-colitis, the lumen of the bowel becomes narrowed and may be obstructed. When these cases are associated with acute obstructive symptoms it is often impossible from a radiological standpoint, as it is in fact during exploratory laparotomy, to distinguish them from carcinomata. However, the X-ray evidence of diverticula in relation to the obstruction and the presence of diverticula elsewhere in the colon afford strong evidence in favour of diverticulitis.

(d) Statistics show that there is no real evidence to prove that carcinoma develops on diverticulitis. Abell (*Surg., Gynec. & Obst.*, 60:370, 1935), in his study of the literature, found an incidence of 1.7 per cent to 8 per cent. Of the 227 cases of diverticulitis requiring surgical treatment, Rankin found co-existent cancer in only four cases, and in the 679 cases of cancer of the colon which were investigated by him, co-existent diverticulitis was discovered in only four instances.

7. Colo-Vesical Fistula. Urinary symptoms may be described as severe in some 10 per cent of cases of diverticulitis, and a fistula develops between the colon and the bladder in about one-third of these severe cases. The inflamed segment of gut, usually the lowest portion of the pelvic colon, becomes adherent to the bladder and an extensive infiltration soon ensues. The inflammatory process then follows one of two courses: (a) resolution with healing; or (b) progression with perforation and fistula formation.

The opening into the bladder is most frequently situated near the apex on the postero-superior wall to the left of the middle line, while in a few cases it will be found at the base of a point posterior to the inter-ureteric bar. In Edwards' series (1939) of 79 cases, bladder symptoms were of a severe nature in 8, and in 3 of these a colo-vesical-fistula was present. Lett (*Proc. Roy. Soc. Med.*, 25:1811, 1931) carefully analysed 172 cases of diverticulitis and found that urinary symptoms were present in 17 and that 7 of these had a colo-vesical fistula. In Lockhart-Mummery's series of 136 cases (*Lancet*, 2:1401, 1938) no fewer than 12 developed this complication. Diverticulitis is the

commonest cause of fistula between the bladder and the colon, and this statement is confirmed by Higgins (*J. Urol.*, 36:694, 1936), who in a study of 382 cases of colo-vesical fistula found that 92 were due to diverticulitis and that 48 were caused by cancer of the sigmoid colon or rectum.

The onset of the bladder symptoms corresponds with an acute attack of low abdominal pain accompanied by pyrexia and constitutional disturbances. The patient soon complains of urgency, pain and frequency of micturition, and of the passage of offensive creamy urine. Air (pneumaturia) and faeces are then passed per urethram. In the early stages of the disease the daily and nocturnal frequency is a most distressing feature. For some days the urine passed may be of the consistency of pea soup. There may also be repeated attacks of strangury, of severe dysuria or of retention of urine. Hæmaturia may occur, but is not a constant symptom. In a number of cases the symptoms suddenly subside (there is no pain, no frequency of micturition, and the urine which is passed is clear and odourless) only to recur again after a while with added vehemence. The bladder frequently develops a strange immunity to faeces, with the result that the accompanying cystitis is often mild in character, ascending infection occurs infrequently and epididymo-orchitis is rarely seen.

The diagnosis of colo-vesical fistula can usually be made from the clinical history alone and can be readily confirmed by cystoscopy. A barium enema X-ray examination of the pelvic colon is of value in excluding the possibility of a malignant fistula. In the presence of cancer the fistula is always of the direct type, its mouth is large, the typical filling defects can be made out in the involved portion of gut. In the case of diverticulitis the fistula is always of the indirect type and the opaque medium seldom enters the long and sinuous tract.

Before performing cystoscopy, it is advisable to keep the bowels constipated for a day or two, and also to wash out the bladder thoroughly on several occasions. It is surprising how often the bladder mucous membrane appears normal on cystoscopy and what a clear view is obtained of the patch of œdematous granulation tissue which marks the point of the fistulous opening. On occasion bubbles of gas may be seen issuing from the mouth of the fistula, or a strong jet of dark liquid faecal matter may suddenly cloud the field of vision and render further investigation temporarily impossible.

RADIOLOGICAL APPEARANCES OF DIVERTICULITIS

The earliest suspicion of diverticula of the colon is an irregularity of haustration in a spastic type of gut. The earliest positive finding is "pinhead" elevations on the surface of the bowel. The next stage is that described as the "saw-edge" appearance. At a later stage still, a series of pear- or flask-shaped protrusions are seen, while an advanced stage may be said to be reached when the diverticula look like little spheres attached to the bowel by slender stalks (figs. 238, 239 and 240). When the diverticula are partially or wholly filled with inspissated faecal debris, a variety of appearances are obtained in the skiagrams, all of which are due to incomplete or irregular filling of the pouches with the opaque medium.

PROGNOSIS

In my experience not more than 10 per cent of patients suffering from diverticulitis develop complications of such a serious nature as to warrant operative interference. In Rankin's series the incidence was one patient in every eleven. In Spriggs' series of 152 patients, 25 required operation, while of Lockhart-Mummery's series of 136 cases no fewer than 91 were treated by operation. Lockhart-Mummery's figures are not truly representative, as he himself states in his paper, since a large number of advanced cases were referred to him for treatment. In his article in the *Lancet* (1938) he makes these observations:

Many of the patients who were not treated by operation have been kept under observation for many years and examined by X-rays and a barium enema at yearly intervals, and it has been observed that, although by keeping strictly to the petroleum regime patients have remained completely free from symptoms, in all cases the diverticula have increased both in size and number. Small diverticula have become larger, and fresh diverticula have appeared in previously free areas of the colon. This is an important observation, for it shows that the weakness of the musculature of the bowel wall and the tendency to herniation of the mucous membrane once started cannot be arrested. In the whole series of 136 cases (91 were treated by operation and 45 by medical measures) there were 15 deaths directly attributable to diverticulitis, a mortality of a little over 10%.²

² Lockhart-Mummery, *Lancet*, 1938.

The prognosis depends principally upon the stage of the disease and upon the type of treatment instituted. If a patient has diverticulosis and the condition is recognised, and "constipation, putrefaction, infection and irritation" (Bassett) are with studious care elimi-



FIG. 238.—BARIUM ENEMA X-RAY EXAMINATION SHOWING DIVERTICULOSIS OF THE PELVIC COLON AND A LARGE BENIGN ADENOMA OF THE TRANSVERSE COLON. (Bull.)

nated, it is probable, nay it is almost certain, that he will be kept relatively symptom-free although the disease is slowly progressive.

There is no surgery of diverticulosis, and the surgery of diverticulitis today deals only with its more pressing complications.

Colostomy is the safest and the most satisfactory form of treatment for cases in which complications have occurred. This procedure is associated with a mortality of about 10 per cent; thus in Lockhart-Mummery's series there were 38 colostomies, following which four of the patients died and thirty-four survived for long periods without any notable symptoms.



FIG. 239.—DIVERTICULOSIS OF THE PELVIC COLON. (Calthrop.)

The liability of patients with diverticulitis to develop septic foci, such as severe cystitis, neuritis, fibrositis, spondylitis, endocarditis, iridocyclitis, and brain abscess, receives special mention from Spriggs (1929).

TREATMENT

Diverticulosis and Mild Uncomplicated Diverticulitis. The treatment is directed to the prevention of complications and may be briefly sketched as follows:



FIG. 240.—EXTENSIVE DIVERTICULOSIS OF THE COLON. (Graham Hodgson.)

(a) A non-residue diet. The patient is kept on a nutritious non-residue diet with an ample vitamin contents.

(b) Elimination of all focal sepsis.

(c) Medicines: (i) if achlorhydria is present, a mixture containing hydrochloric acid should be prescribed; (ii) liquid paraffin is given in sufficient quantity to ensure daily evacuations and to render the stools soft. Purgatives are not allowed; (iii) a mixture containing tincture of hyoscamus, 15 mms., is given four-hourly whenever pain is a troublesome feature.

(d) Douthwaite recommends—"3 oz. daily of freshly prepared culture in sterile milk of 200,000 lactic acid bacilli to the cc. Alternatively give sauerin (Martindale) tablets, 4-6 daily by mouth, if non-lactose fermenters are present in the *faeces*. Two drachms of lactose should be given twice daily with milk or with food. This acts as a mild laxative and discourages the growth of non-lactose fermenters."

(e) Colon wash-outs. Low-pressure wash-outs (18 inches high) with normal saline on alternate days are given to those patients who complain of symptoms suggesting mild infection.

Acute Diverticulitis without Complications. The treatment recommended for these cases is based on Ochsner's methods for the management of the localised appendix mass: The patient is kept in bed in the half-sitting position throughout the acute stage and for at least another week after the inflammatory process has completely subsided; morphia, gr. 1/6, is injected subcutaneously twice or three times a day if pain is a prominent symptom; heat is applied to the abdomen and especially to the affected area; no purgatives and no enemata are allowed; no fluids or fluid nourishment in any form is given by mouth while the inflammation is at its height; glucose-saline is run slowly into a vein by the drip method during the time that nourishment by mouth is withheld; intramuscular injections of sulphapyridine may be indicated; and paraffin is prescribed if the bowels remain obdurate after the fourth day of treatment. If the bowels have not moved by this time, a warm glycerine or olive oil enema is given, and this is repeated daily. The combination of paraffin by mouth and glycerine per rectum ensures the most satisfactory evacuation in these cases. It should be a rule that no solid food be permitted until there is a sustained all-round improvement in the patient's general condition.

When the stage of convalescence is reached, the patient is treated on the lines laid down above for diverticulosis and mild uncomplicated diverticulitis.

Are there any indications for operation in these cases of acute diverticulitis? If complications can be excluded with assurance there are no indications of which I am aware, but if doubt lingers—if the presence of an acute perforation cannot be excluded by clinical methods after a period of watchful waiting—the wisest plan is to “look and see.” I cannot accept: (*a*) recurrent exacerbation of inflammation; (*b*) the onset of bladder symptoms, or (*c*) the symptoms of low-grade large-gut obstruction as genuine indications for operative interference. They are rather to be regarded as urgent pleas for more intensive and perhaps more efficient methods of medical management.

INDICATIONS FOR OPERATIVE TREATMENT

The indications are the complications of diverticulitis:

1. Acute diverticulitis with perforation and spreading peritonitis.
2. Acute diverticulitis with localised abscess.
3. Acute large-gut obstruction.
4. Colo-vesical fistula.

Acute Diverticulitis with Perforation and Peritonitis. This is an urgent condition demanding immediate operation. The abdomen should be opened by a median sub-umbilical incision, a left low paramedian incision, or a left oblique muscle-cutting incision. The oblique incision is probably the best and should be employed in most cases and especially when the patient is obese.

There are three stages in the operation:

1. The packing off of the abdomen to prevent the spread of infection; the search for the perforation; and the closure of the perforation (when found) or the treatment of the inflamed segment of bowel when the perforation is not discovered.
2. Drainage: (*a*) of the pelvic cavity and the region of the perforation, and (*b*) of the colon—proximal colostomy.
3. Closure of the abdominal wound.

As soon as the abdominal cavity is opened, any free pus is aspirated and the viscera are carefully packed off to prevent any spread of the infection. A close search is then made for the perforation. The per-

forated diverticulum may be lying free and the surrounding gut wall may not be unduly œdematous or grossly diseased. In these cases the diverticulum should be excised and the small hole in the bowel should be closed with a few interrupted catgut sutures, after which an adjacent appendix epiploica or a small portion of omentum is sutured over it for added safety.

By an alternative method three interrupted sutures of chromic catgut are introduced, one above the perforation, one through it, and one below it, and the free edge of the omentum is drawn over the site and tied securely in position over the hole. When the omentum is short and whenever it cannot be laid snugly over the perforation, it is better to use a free graft. If the perforation has occurred through a stiffened, œdematous and acutely inflamed area of the gut, closure by the above methods may be impracticable, and the safest plan is to stitch the omentum over the whole inflamed surface or to wrap it freely around the involved segment.

When the actual site of the perforation cannot be found, the surgeon has a choice of two procedures:

(1) Exteriorisation of the acutely inflamed portion of the colon; or (2) wrapping and suturing the omentum around the involved segment of bowel.

After the perforation has been attended to, the next step consists in the performance of proximal colostomy and establishing free drainage of the abdominal cavity. I have, on occasion, after closing the perforation, contented myself with drainage of the pelvis alone. To my regret the mortality in these cases was very high and the few patients who survived subsequently developed irksome and permanent fœcal fistulæ which, in my experience, are incurable without the aid of graded procedures.

A proximal colostomy by the Devine plan is, in my opinion, an indispensable undertaking in all cases of diverticulitis complicated by perforation and *localised* peritonitis. I dislike the simple loop type of colostomy, whether carried out upon the sigmoid loop itself, the mobilised descending colon or the transverse colon, as its subsequent closure, should this step prove necessary, is a major operation associated with some very definite risks (see page 1331). The performance of loop colostomy can only be countenanced in patients who are desperately ill and in those in whom the peritonitis instead

of being localised is *generalised*. For such cases I would regard it as a simple and expeditious emergency method.

When the patient's condition is satisfactory, when he is standing the operation successfully, and when peritoneal exudate is scanty and confined to a limited area, the procedure of choice is, as I have said, transverse colostomy by Devine's method (see page 1228). After drainage tubes have been inserted down into the pelvis and to the site of the perforation, the edges of the abdominal wound are approximated with a series of interrupted sutures of stainless alloy steel wire (Babcock) or with No. 8 plaited silk passed through *all* the layers of the abdominal wall from side to side. The wire sutures are twisted cautiously so as to effect an even approximation of the edges of the wound, and if silk sutures are employed they are tied lightly so as to avoid strangling the tissues in their embrace. It is a wise precaution to drain the subcutaneous tissues with sheets of corrugated rubber. Infection of the wound, dehiscence, evisceration and incisional hernia are common post-operative sequelæ; hence my abandonment of the more orthodox method of closure of the incision layer by layer with catgut stitches.

As soon as the abdominal wound is closed, a small right epigastric transrectus incision about 3 inches in length (large enough to admit the hand) is made, some 2 inches from the middle line. Through this incision the transverse colon is picked up and drawn through the wound and a defunctioning colostomy is fashioned.

After the performance of this operation the left half of the colon is completely defunctioned and thus placed at rest. As fæces cannot pass across the bridge of skin from the proximal to the distal stoma, contamination is prevented; the colostomy is easy to manage and is not unsightly, and, when necessary, intestinal continuity can be speedily, painlessly and safely established by means of a special enterotome.

The alternative to colostomy is cæcostomy or appendicostomy, but in my opinion neither of these operations provides satisfactory drainage of the bowel and can only therefore be recommended when the patient refuses to give consent to the formation of an artificial anus.

After-Treatment. The immediate post-operative treatment is conducted much on the same lines as that adopted for cases of acute perforative appendicitis. Colon irrigations are commenced during

convalescence as soon as the inflammatory condition shows unquestionable signs of relenting. A determined attempt must be made to rid the distal segment of colon of its retained decomposing faecal contents by means of daily irrigations with warm normal saline solution or crude cod-liver oil. It takes on an average three weeks to render the colon reasonably clean by these means, and in the average case it is fully one year before the colostomy can be closed with safety. The patient should be carefully re-examined at the end of the first year after operation. If his general condition is good, if he is symptom-free, if a barium meal examination shows that the lumen of the gut is everywhere amply patent and there is no evidence of gross disease, the colostomy may then be closed and the continuity of the bowel be restored once again.

If in a favourable case skiagrams reveal that a small portion of the sigmoid colon is permanently strictured or that the full brunt of the disease has spent itself upon a circumscribed segment but the remainder of the large gut is otherwise tolerably healthy, the procedure advocated would be resection of the involved bowel followed by end-to-end anastomosis and closure of the colostomy three weeks later.

If the patient is aged, decrepit or very obese; if the X-ray pictures show that there is an extensive area of narrowing, that the disease is widespread and advanced in different areas of the colon, or that the lowest portion of the sigmoid loop is seriously implicated; or if there are marked and persistent urinary symptoms, continued discomfort or pain, or other unfavourable features, it is clear that the colostomy must be retained for an indefinite period.

Acute Diverticulitis with Localised Abscess. The abscess should be opened and thoroughly drained. The immediate prognosis is good, but a faecal fistula is the almost inevitable issue. If the fistula does not prove too irksome to the patient it may safely be left alone. Closure of such a fistula is a difficult undertaking and entails: (1) a Devine colostomy; (2) frequent irrigations of the colon; (3) excision of the fistula, and (4) closure of the colostomy.

To close the fistula without first performing a colostomy above it is to invite disaster or at least the formation of a huge intra-abdominal abscess.

Acute Large-Gut Obstruction. The treatment here is colostomy. Most surgeons advocate the performance of a simple loop colostomy

just above the obstructing mass, *i.e.*, to the descending colon, or to the proximal portion of the sigmoid loop if this is not affected; but I am partial to colostomy as applied to the transverse colon by the Devine method.

Colo-Vesical Fistula. It must be laid down as a rule that no attempt should be made to close such a fistula when caused by diverticulitis until a defunctioning colostomy has been performed and until all infection has been satisfactorily eliminated from the bladder and from the kidneys. The operation is carried out in three stages:

1. Transverse colostomy. The distal colon should be washed out regularly every day for at least three months before embarking upon the next procedure.

2. Excision of the fistula. Through a median sub-umbilical incision, the bladder is exposed and then carefully dissected free from the involved sigmoid colon; the opening into the bladder is securely closed by two purse-string sutures; the hole in the sigmoid is closed with a series of interrupted Lembert or through-and-through sutures; a fair portion of the great omentum is imposed upon the sutured openings; suprapubic drainage is provided; the abdominal incision is approximated in layers, and the bladder is drained by an indwelling catheter (passed per urethram).

3. Closure of the colostomy. The colostomy should in the average case be kept working for at least one year after the performance of the second operation. After this time if there are no untoward symptoms, it can be closed with safety. The late results following these graded procedures are on the whole very satisfactory.

CHAPTER 7

THE SURGICAL TREATMENT OF ULCERATIVE COLITIS

The disease seems to have been known to Sydenham (*Works of the Sydenham Society*, London, 1:166, 1848), who in 1669 described the "bloody flux." Cullinan (*Brit. M. J.* 2:1351, 1938) in his instructive contribution states that ulcerative colitis was first described by Allchin in 1885 and by Hale-White in 1888, and discovered at necropsy by Samuel Wilks in 1875.

DEFINITION

In non-specific or idiopathic ulcerative colitis there is severe inflammation of the mucosa and the submucosa of the large bowel, generally with superficial ulceration. When a late stage is reached, the deeper layers of the gut wall are also affected. Although the whole colon is often involved, the lesion nearly always predominates in the distal colon and rectum. The infection most frequently starts in the rectum or sigmoid and then spreads in an upward direction, i.e., toward the transverse and ascending colon. In a few cases the infective process is not halted until the last few inches of the terminal ileum are similarly implicated. Clinically, the condition is characterised by diarrhoea and the passage of blood, pus and mucus in the stools.

The onset may be insidious but more commonly it is sudden. It is interesting to note that the nature of the onset has no relation to the subsequent severity of the disease which, on the whole, tends to pursue a chronic course, lasting many months or even years and being marked by a succession of relapses and remissions.

OPERATIVE TREATMENT

Many patients suffering from ulcerative colitis respond in a satisfactory manner to a well-planned course of medical treatment such

as that advocated by Hurst (*Brit. M. J.*, 1:320, 1936), Bargaen (*Lancet*, 2:1040, 1936), Cullinan (1938) or Tidy (*Med. Press & Circ.*, 197:372, 1938). At the present time it is probably true to state that no specific therapy has yet been devised and that the success of any particular remedy (*e.g.*, sulphapyridine or Bargaen's serum) is no proof of its specificity. Surgery is required in not more than 20 per cent of the cases, and its indications are as yet most difficult to define with any precision. At one time operative measures were invoked only where a lethal outcome appeared inevitable in spite of assiduous medical attention; but today a more sanguine attitude is adopted in seeking to apply them neither too early nor too late to fulfill their purpose.

INDICATIONS FOR OPERATION

The indications for operative interference are: (1) failure of the patient to respond to *efficient* medical treatment, and (2) the presence of complications such as perforation, stricture, diffuse polyposis, suspected malignant degeneration, fistulæ and severe perirectal suppuration. In the first group must be included:

- (a) Steady deterioration in the general and mental condition;
- (b) Marked and progressive loss of weight with dehydration;
- (c) Intractable diarrhœa;
- (d) Severe hæmorrhage which proves difficult or impossible to control with blood transfusions;
- (e) Acute toxæmia, and
- (f) Constant racking abdominal pain.

CHOICE OF OPERATION

The following are some of the operations which are or have been employed in the treatment of ulcerative colitis: (1) appendicostomy; (2) cæcostomy; (3) colostomy; (4) ileo-sigmoidostomy; (5) ileostomy: (a) loop ileostomy; (b) terminal transverse ileostomy; (6) terminal ileostomy followed later by (terminal) side-to-side ileo-ileostomy to restore the continuity of the alimentary canal; (7) terminal ileostomy followed later by partial colectomy (two stages) and then by abdomino-perineal excision of the rectum; (8) terminal ileostomy followed later by partial colectomy and then by ileo-sigmoidostomy or

by implantation of the distal ileum into the upper portion of the rectum; (9) abdomino-perineal excision (in two stages) followed later if needs be by segmental resection of the colon.

Appendicostomy. Although this operation still has a place in the treatment of acute colonic obstructions, in the pre-operative preparation of the patient for abdomino-perineal excision of the rectum for cancer, in the management of certain complications of diverticulitis, etc., it is now rarely employed in cases of ulcerative colitis, as the drainage afforded by this procedure is minimal, it does nothing to deflect the fecal stream from the inflamed and ulcerated mucosal surface, and the feeble flushing of the colon which it permits is not so effective as washing out through the rectum. Nevertheless, it certainly affords relief and may even hasten a cure in the occasional case. It is for this reason perhaps that it has not as yet fallen completely into disfavour in certain clinics.

The operation may be performed in the following manner: Under local anæsthesia the appendix is withdrawn through a small right-sided gridiron incision, and after carefully mobilising it by division of any surrounding adhesions and bands, the organ with its undamaged mesentery is examined to ascertain whether it is healthy, of adequate size and length, and whether or not the lumen is sufficiently patent to accommodate a special rubber catheter. If the appendix is considered to be suitable for appendicostomy, its tip is drawn inward toward the middle line and then anchored to the skin without any tension in that region by a single silk stitch (which picks up an avascular spot in the meso-appendix). The incision is then loosely and partially closed, enough room being left at its medial end to ensure that the tethered appendix and its feeding vessels are not compressed or kinked. A gauze swab soaked in paraffin and flavine is passed beneath the appendix as it lies on the surface of the abdomen and the wound is dressed in the usual manner. About four to six days after the operation, the meso-appendix is infiltrated with a few cubic centimetres of novocaine, and the distal two-thirds of the appendix and its attached mesentery, which are now firmly adherent where they issue through the abdominal incision, are amputated with a cautery in the manner depicted in figure 241.

The stump of the appendix, together with its ligatured mesentery, is left projecting at least half an inch from the surface of the skin

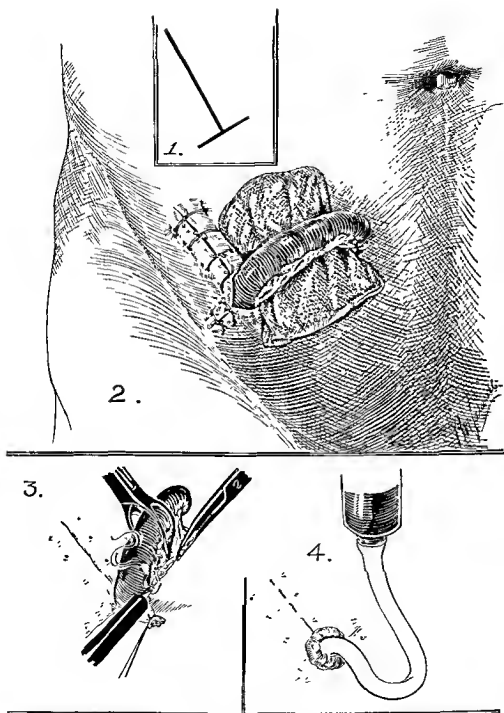


FIG. 241.—APPENDICOSTOMY.

to allow of some retraction. The lumen is next sought for with a probe and slightly dilated before introducing a No. 7 tapered rubber appendicostomy catheter. The catheter should be left in position for three or four days to ensure an adequate stretching of the newly-fashioned stoma. Irrigations with warm olive oil, crude cod-liver oil, normal saline, 0.5 per cent tannic acid solution, etc., are commenced at once and repeated as often as may be required. When no longer required for purposes of irrigation, the appendicostomy may be closed by canterising the short mucosal tunnel or by dissecting out the appendix stump and excising it. The base of the appendix is then invaginated into the cæcum as in the operation of intra mural implantation. My experience of appendicostomy in cases of ulcerative colitis is limited to only two cases, in both of which unfortunately there was no subsequent improvement in spite of repeated irrigations and the best medical care. It is unlikely that I should ever again employ this operation in the treatment of this disease.

Cæcostomy. The technique of cæcostomy is described on page 1116. This operation possesses no distinct advantages over appendicostomy except that it is easier to perform. Cæcostomy has been supplanted by terminal ileostomy.

Colostomy. Transverse colostomy may sometimes be indicated where on sigmoidoscopy and on X-ray examination of the colon the inflammatory process appears to be strictly limited to the rectum and sigmoid loop. As the disease travels along the bowel wall, as it were in an anti-peristaltic direction, it is considered essential to transect the selected loop (usually the transverse colon) and to fashion a double-barrelled colostomy instead of performing a simple loop colostomy. If colostomy could replace terminal ileostomy in the relief of toxæmia and as a life-saving operation, it would, of course, result in a more comfortable state for the patient. However, because of the tendency of the disease to have extended upward in those cases which are severe enough to require surgery, this procedure can rarely be adopted (Jordan and Everett, 1933).

Ileo-Sigmoidostomy. By this method the last loop of ileum is anastomosed to the lowest portion of the sigmoid colon with the object of putting the infected colon at rest. Would that it did so! In the majority of cases its effects are disastrous, as it shunts the full force of the ileal current with its *corroding* contents on to that portion of

the alimentary canal which is the most sorely crippled by the primary onslaught of the infection.

Ileostomy. There are many types of ileostomy:

1. Simple loop ileostomy; 2. Terminal transverse ileostomy: (a) end or single-barrelled ileostomy—Rankin's method; (b) Cattell's method of implantation of the proximal and distal loops of the ileum into separate incisions—the distal non-functioning ileum being in direct line with the incision for the subsequent colectomy (should this step prove necessary).

Simple Loop Ileostomy. This operation is selected when the patient is extremely ill. It is performed very rapidly under local anæsthesia, much in the same manner as loop colostomy.

End or Single-Barrelled Ileostomy. By Rankin's technique the last foot of the ileum is withdrawn through a low right transrectus or gridiron incision, the intestine some 8 inches from the ileocæcal valve is severed between crushing clamps, the ileo-mesentery opposite the transection is divided for a short distance to allow of adequate immobilisation of the proximal loop, the distal end of the gut embraced in the crushing clamp is securely closed and then dropped back into the abdomen, and the proximal or functioning loop of ileum is made to project from $1\frac{1}{2}$ to 2 inches above the incision, which is then closed around it.

At the completion of the operation when the wound has been sealed off with adhesive dressings, a Winsbury-White type of catheter or a rubber drainage tube is introduced into the intestine and sutured or tied close to the cut margins of the bowel. This is a very satisfactory operation, as

the colon, no longer filled with bacterial pabulum, mechanically irritated, or stimulated to contract, rapidly becomes more healthy. It is not to be expected, in the advanced type of case in which such a grossly destructive operation as colectomy has come to be considered, that it will recover sufficiently to function again, but the discharge becomes one of purulent mucus, rapidly decreasing in amount, bleeding gets less or stops entirely, and the absorption of toxins is diminished when infected fluids no longer reach the ulcerated surfaces and mass movements do not aid the lymphatic and venous flow. Almost as important as the mechanical exclusion is the fact that the diet need no longer be chosen to spare the colon. Part of the difficulty in treating the disease is to provide a diet that gives a minimum residue, yet is varied, appetising, and sufficient in all elements. After ileostomy the patient may be fed on anything

and everything, and this alone causes a marked improvement. To start with, the ileal efflux is watery and almost continuous, dehydration is apparent, and the skin round the opening gets sore. But the capacity to absorb water is soon acquired, and the outflow takes the consistency of putty and is discharged at intervals that may be as long as four hours.

As soon as the patient's condition will justify a further operation the diseased colon is removed.¹

Terminal Ileostomy by the Methods of Cattell. Cattell (*Surg. Clin. N. Am.*, 19:629, 1939) holds the view that the ideal ileostomy should fulfill the following requirements:

1. The functioning ileostomy stoma should be placed in such a position on the abdominal wall that it will not be too conspicuous; also so that it may be easy to manage with the aid of an ileostomy belt.

2. The site of the ileostomy should be such that the later incision for colectomy (if required) will not be interfered with.

3. The terminal ileum should be securely anchored to the abdominal incision so that it cannot prolapse or withdraw into the abdominal cavity.

4. The position of the ileal loop leading up to the ileostomy stoma should be placed in such a position that subsequent intestinal obstruction is prevented.

5. The functioning ileal loop should be made to project at least 1½ inches from the incision (which is closed around it) so that the irritating intestinal discharges are not delivered directly on to the skin.

Technique of the Double-Barrelled Ileostomy. The operation is performed under local anæsthesia. A vertical incision 2½ to 3 inches long is made over the lower half of the right rectus muscle at the junction of the inner and middle thirds and starting just below and slightly to the right of the umbilicus. The muscle is split in line with its fibres, the peritoneum is opened and each margin is picked up and retracted, and the last 2 feet of ileum are drawn on to the surface of the abdomen. No exploration is conducted nor is the colon palpated to detect the extent of the disease lest the infection be disseminated into the general peritoneal cavity.

The ileocæcal valve is identified and if the terminal loop of ileum is not involved in the inflammatory process, although in some 20

¹ Oglvie, *Brit. M. J.*, 2 1197, 1938.

per cent of cases this segment is found to be diseased, a portion of intestine about 8 to 10 inches from the ileocaecal junction is selected for the ileostomy. The peritoneum of the ileo-mesentery is then carefully incised with a scalpel vertically on each side so that two or three of the arching blood vessels can be isolated, ligatured off in two places and divided, thus allowing of a fair degree of mobility when the bowel is transected.

If the patient's condition is poor, a double-barrelled ileostomy is performed; but if he is considered to be a fair operative risk it is better to implant the distal and proximal ileal loops into separate incisions.

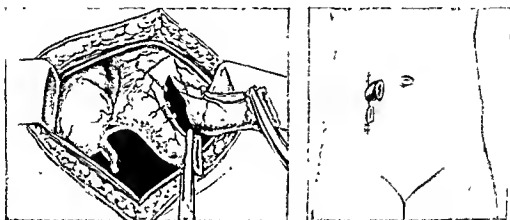


FIG. 242.—THE DOUBLE-BARRELLED ILEOSTOMY—BY CATTELL'S METHOD.

By the first method the ileum is divided with a cautery between Kocher forceps, and after stitching the cut edges of the mesentery to the parietal peritoneum, the loops are withdrawn and placed in apposition one above the other (fig. 242). The upper or proximal functioning stump should be made to project at least $1\frac{1}{2}$ to 2 inches above the sutured incision, while the lower non-functioning stump is left at the level of the skin, grasped in the jaws of Kocher forceps.

A rubber tube is inserted into the upper loop and tied in position with a purse-string suture.

Terminal Ileostomy with Implantation of the Proximal and the Distal Ileal Loops into Separate Incisions. The preliminary steps in this operation are identical with those just described up to the point where the intestine is ready to be divided. Through a small stab

incision at the outer border of the right rectus muscle, and placed slightly above the upper margin of the first incision, a pair of curved artery forceps is passed to grasp the distal ileum. Another hæmostat is then applied through the original muscle-splitting incision beside it on the proximal ileum, and the intestine is cut through with a cautery. The distal loop is immediately withdrawn through the stab incision and the skin edges are approximated with one or two interrupted sutures. The bowel is not stitched to the parietal peritoneum, as the clamp is left in situ for about four days, during which time the gut becomes firmly adherent to the abdominal wall and does not retract when the clamp is removed.

The proximal or functioning ileal loop is now raised and the free edge of the mesentery is sutured to the under-aspect of the parietal peritoneum (fig. 243). The margins of the peritoneum and rectus muscle are then loosely drawn together around the projecting ileum so that its feeding blood vessels are not compressed or caught up in any stitch. The ileum itself is not sutured to the peritoneum since a fistula might result, even when such sutures are introduced cautiously and take up only small bites of the seromuscular coats of the intestine. The tension upon such anchoring sutures may be very great, with the result that they may cut out or lead to a localised area of gangrene, to subsequent perforation and peritonitis or spreading suppuration of the layers of the abdominal wall. The wound is closed about the ileum, but the anterior sheath of the rectus muscle is not sutured.

After removing the clamp on the proximal ileum, a rubber tube or catheter is introduced into the bowel and stitched there with a purse-string suture of silk. The wounds and an area of the surrounding abdominal wall are protected with adhesive waterproof sheets before applying the final dressings (this is illustrated in fig. 243).

After three days the discharge from the ileum becomes too thick to pass readily through the catheter, and when this occurs a small Winsbury-White tube should be substituted for the catheter and drainage should be aided by means of continuous suction applied to the distal end of the tube. After the first week it is futile to persevere with catheter drainage, and the proximal end of the intestine is allowed to discharge freely into voluminous dressings. The adhesive

protective sheets and the skin stitches are removed on the seventh day, and after thoroughly cleansing the abdominal wall a wide area is lavishly painted with mastisol or tincture of benzoin. One of the following applications may also be applied to mitigate burning and

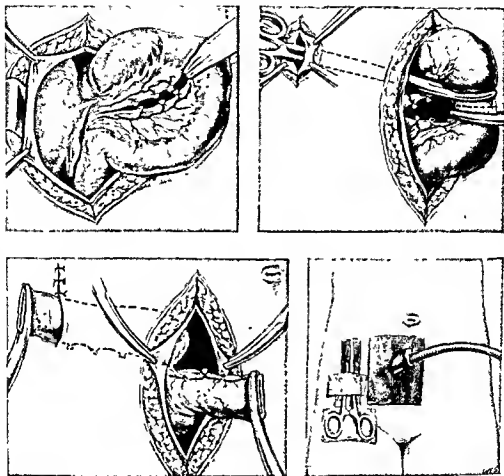


FIG. 243.—TERMINAL ILEOSTOMY WITH IMPLANTATION OF THE PROXIMAL AND DISTAL LIMBS OF ILEUM INTO SEPARATE INCISIONS—CATTELL'S METHOD.

blistering of the skin: kaolin, Fuller's earth, or aluminium or bronze paste.

As soon as the wounds are soundly healed, an ileostomy bag, as made by the Genito-Urinary Manufacturing Co., is ordered. If the stump of ileum projects sufficiently, the intestinal contents will be discharged directly into the rubber bag without much soiling of the skin.

The complications which may arise after the performance of terminal ileostomy may be enumerated as follows:

1. Perforation of the cæcum or of the distal loop of ileum. This is a very rare event.

2. Prolapse of the mucous membrane of the ileum through the stoma. This is often due to excessive mobility of the ileo-mesentery.

3. Recession of the ileostomy: (a) between the layers of the wound; (b) into the peritoneal cavity.

4. Compression of the ileal loop as it passes through the layers of the abdominal wall.

5. Gangrene of a portion or of the whole of the exteriorised ileal loop.

6. Secondary openings proximal to the ileal stoma (due to stitching the intestine to the parietal peritoneum) leading to peritonitis or infection of the wound.

I have made the mistake of fashioning a distal stoma in a stab incision placed parallel to the functioning ileostomy, with the result that it proved most difficult to fit a suitable belt; of injuring the ileocæcal artery with consequent necrosis of a fair segment of gut, and of underrunning the vessels in the mesentery attached to the gut while anchoring this structure to the peritoneum, thereby imperilling the blood supply to the exteriorised loop.

The mortality of terminal ileostomy in Cattell's safe hands is 22 per cent; in my small series more than 40 per cent of the patients have died. This latter death-rate is much too high, and may be attributed to selection of the wrong type of operation in those patients who were exsanguinated or suffering from advanced toxæmia or to such faults in operative technique as I have already mentioned. If terminal ileostomy is carried out at the right moment—neither too early nor too late; if simple loop ileostomy is selected for the poor risks; and if the operation is carefully performed, the mortality should not be higher than 30 per cent.

The late results of ileostomy as a whole are encouraging, as in most of the cases toxæmia is banished; the health improves; weight is gained; diarrhœa is checked; the sanguineous mucopurulent discharge through the rectum slowly abates; and in a few fortunate instances the infected rectum and colon may appear on repeated sigmoidoscopic and X-ray examination (barium enema and double-

contrast enema) to be restored both anatomically and functionally to a relatively normal condition. Although some 80 per cent of the survivors of this operation return to a measure of activity and reasonable good health, not more than a very few of these can hopefully look forward to the day when their ileostomy will be taken down and the intestinal stream diverted into its accustomed channel. In other words, in the great majority of the cases the ileostomy is permanent; it is permanent whether the diseased colon remains in situ or whether it is subsequently excised.

Cattell (*Lahey Clinic Bull.*, 1:2, 1939), in an analysis of 200 cases of ulcerative colitis treated at the Lahey Clinic during the past seven years, has shown that 66 of these were subjected to operation. It will be noted in the accompanying table that ileostomy was carried out on 55 occasions.

TABLE 1
ULCERATIVE COLITIS

Number of patients	200
Number of patients operated upon.....	66
Ileostomies	55
Partial colectomies	11
Complete colectomies	24

Terminal Ileostomy Followed Later by Restoration of the Intestinal Continuity.

We consider ileostomy to be the price that these patients pay for life and it must be accepted as a permanent thing in these patients with the severe form of the disease and the common complications associated with it. There is one favorable feature in the treatment of these cases after early ileostomy is elected. While in the past we have considered ileostomy as a permanent necessity in these cases, in the last five years we have been able to close the ileostomy with restoration of intestinal continuity in four patients in whom ileostomy was done early and satisfactory healing in the colon followed. It seems possible that if early ileostomy is done in some of these cases closure of the ileostomy may be done more frequently.²

I have performed this operation on one occasion following a Rankin type of terminal ileostomy. The subsequent progress in this special instance was very pleasing.

² Cattell, *Lahey Clinic Bull.*, 1:2, 1939.

The operation for restoring intestinal continuity in cases such as these is relatively simple. In the Rankin operation the functioning ileostomy loop is freed from the abdominal incision, amputated, and the proximal end of the intestine is closed and invaginated, after which a side-to-side ileo-ileostomy is carried out close to the ileocæcal junction.

In the Cattell operation both loops are dissected free from their respective incisions in the abdominal wall, and, after cutting away the portions that had been exteriorised and inverting and securely closing the ends of both loops, anastomosis is effected between them by the side-to-side method.

Terminal Ileostomy Followed later by Partial Colectomy (of the Proximal Half of the Colon) and then by Ileo-Sigmoidostomy to Restore Intestinal Continuity. This operation may succeed in those cases where during the course of a chronic case the disease has never at any time ravaged the lower reaches of the large bowel and rectum. It can never be a rational procedure to anastomose the ileum to the sigmoid or to the rectosigmoid if there is any disease whatsoever in the distal segment of the bowel. It should be remembered that the rectum and sigmoid are primarily implicated in 80 per cent of the cases and it is therefore self-evident that this operation can at best have only a very limited scope.

Terminal Ileostomy Followed by Partial or Complete (Total) Colectomy. In most of the chronic cases and more especially where the bowel is extensively scarred and strictured, where polyposis is apparently a diffuse condition, where malignant change cannot be ruled out, where fistulæ and sinuses are dreaded superadded complications, or where, in the absence of radiological evidence of complications, diarrhœa cannot be controlled, bleeding is not restrained, or the patient's general health continues for one reason or another to deteriorate in spite of a well-functioning ileostomy and efficient medical treatment, partial or complete colectomy is the procedure of choice.

In those cases in which the infective process is confined to one portion of the colon, partial colectomy will suffice, but in order to ensure a complete eradication of the disease most patients will require total colectomy.

Total colectomy involves removal of a small segment of the ter-

terminal ileum, the whole of the colon, and also the rectum and anus. If the ulcerative colitis is limited to the distal half of the large bowel, colostomy of the end type with interruption of the continuity of the bowel can be performed in the transverse colon and the distal half of the bowel be resected. In those cases where the disease has long remained limited to the rectum or rectosigmoid and is perhaps associated with stricture or fistula formation, a two-stage abdomino-perineal excision of the rectum may satisfactorily effect a cure without additional measures. All other operations make the presence of a permanent terminal ileostomy necessary. Cattell states that 21 out of the 24 patients submitted to complete colectomy following ileostomy are living and that most of them manage their ileostomies quite satisfactorily.

TECHNIQUE OF TOTAL COLECTOMY CARRIED OUT IN STAGES

Following terminal ileostomy it is possible in a few fortunate early cases to restore intestinal continuity by ileo-ileostomy with considerable hope of permanent success.

In a few cases, again, although this restoration cannot for a moment be entertained on the grounds that the bowel is too crippled ever to regain normal function, nevertheless, owing to an all-round improvement in the general health which commonly takes place, permitting of a return to a certain degree of activity without any exacerbation of symptoms, colectomy does not become necessary.

In total or complete colectomy the ileostomy is the first stage, and the colon and rectum are removed in two, and in the poor-risk cases in three, stages.

At the second stage, which is usually carried out a few months after the ileostomy, the distal stump of ileum, the cæcum, the ascending colon, the transverse colon and a portion of the descending colon (preserving the left colic artery) are excised in one place. The great omentum with its blood supply is preserved to cover over any raw surfaces which may result from this wide dissection. The distal end of the bowel is implanted into the wound and may be used for purposes of irrigation of the distal segment of the gut.

The third stage, which is generally performed two or three months after the second stage, entails the removal of the remaining portion

of the descending colon, the sigmoid colon, the rectum and the anal canal by a combined abdomino-perineal procedure. In the perineal part of the operation, the coccyx is not cut away, since if this is done the middle sacral artery, which always bleeds freely, may be difficult to pick up and ligature satisfactorily, the bare sacral stump is likely to be painful afterward, and a "quiet" necrosis of the bone may sometimes ensue and interfere with the healing of the wound.

The perineal wound is carefully sutured layer by layer, leaving just enough room in the middle of the incision for the insertion of a cigarette drain.

In the poor-risk cases it is safer to do the complete colectomy in four stages rather than in three. Thus: first stage: transverse ileostomy; second stage: removal of the ileal stump, cæcum, ascending colon and proximal third of the transverse colon (leaving the middle colic artery intact); third stage: removal of the remainder of the transverse colon, the descending colon, and a portion of the sigmoid loop; fourth stage: removal of the remainder of the colon, rectum and anal canal by a combined abdomino-perineal operation.

The interval between the second and third stages and between the third and fourth stages should be on an average two to four months. There is, of course, a much longer interval between the first and second stages, during which period so much needs to be done to effect an improvement in the patient's condition.

CHAPTER 8

CANCER OF THE COLON

Carcinoma is by far the commonest tumour of the large intestine.

Wilkie (*Edinb. M. J.*, 46:1, 1939), in a most enlightening paper to which subsequent reference will be made, points out that at the Royal Infirmary over a period of fifteen years there were more than 900 cases of cancer of the colon, *i.e.*, there were 60 cases per year in a large general hospital. Allen and Welch (*Am. J. Surg.*, 46:171, 1939) have also shown that during the period 1925 to 1938 there were 634 patients with cancer of the colon admitted to the Massachusetts General Hospital, and that the admission rate of these cases was comparable with that of the above. Statistics prove that there is a definite increase in the incidence of cancer of the colon, and this has been attributed to improved methods of diagnosis, to the prolongation of the lifetime of man, to improper diet and to other factors not clearly understood at the present moment.

The frequency of carcinoma in different segments of the colon varies considerably in individual statistical tables. This is probably due to the fact that most of the tumours occurring *near* but definitely *above* the level of the ileocaecal valve have been erroneously classified as cancer of the caecum. It is thus often stated that while the sigmoid colon is the commonest site of malignant disease, the caecum comes next in order of frequency, although in point of fact not more than 5 per cent of cancers of the colon are situated below the level of the ileocaecal valve, *i.e.*, in the caecum proper.

Allen and Welch give the distribution in their 634 cases as follows: sigmoid colon 53.9 per cent; caecum and ascending colon 25.5 per cent; transverse colon 11 per cent; splenic flexure and descending colon 9.6 per cent. Wilkie's figures are shown in table 1 (*Edinb. M. J.*, 46:1, 1939).

TABLE 1
THE SITE OF GROWTH IN 243 CASES OF
CANCER OF THE COLON

	Cases
1. Caecum	17
2. Ascending colon	31
3. Hepatic flexure	5
4. Transverse colon	23
5. Splenic flexure	12
6. Descending colon	20
7. Pelvic colon	135

Hurst (*Lancet*, 1:623, 1939), who combined the figures given by different British, American and Continental surgeons, submits the following table:

TABLE 2
PERCENTAGE INCIDENCE OF CARCINOMA IN DIFFERENT
PARTS OF THE COLON

Large Intestine, Excluding Rectum	Rectum, Excluding Rest of Large Intestine	Whole of Colon Including Rectum
Caecum 15		
Ascending colon 10		
Hepatic flexure 5		
Transverse colon 5		
Splenic flexure 10		
Descending and iliac colon .. 5		
Pelvic colon 50		
Pelvic-rectal flexure	65	
Ampulla of rectum	30	
Anal canal	5	
Total 100	100	100

Hurst holds the view that the high incidence of malignant disease in the sigmoid colon compared with that in the more proximal parts may be associated with the fact that their contents are more solid

and consequently cause more mechanical irritation. The cæcum and ascending colon are affected relatively often because they are more constantly filled than any other part of the large bowel (except, of course, the pelvic colon) and are subjected to irritation by the products of bacterial activity which is greater in them than in any other part of the intestinal canal.

Carcinoma of the colon may occur at any age, and although it is usually encountered between the ages of 40 and 70, the peak incidence being 55 to 65, it is not uncommon to find the disease in patients between the ages of 20 and 30, or even in children and adolescents. Phifer (*Ann. Surg.*, 77:711, 1923) reviewed 23 cases of cancer of the large bowel occurring in children under the age of 16, and Robertson Ogilvie (*Brit. J. Surg.*, 23:601, 1936) described a case of cancer of the cæcum in a boy aged 13, and also collected from the literature 14 cases of malignant disease in the colon, in all of whom the patients were under the age of 17.

Males are more frequently affected than females in the proportion of approximately 2 to 1.

The origin of cancer of the large intestine, like cancer occurring elsewhere in the body, remains obscure, although during recent years some definite progress has been made in respect of its predisposing and contributory causes. Bardenheuer (*Arch. f. klin. Chir.*, 41:887, 1891) was the first to bring forward irrefutable histological evidence of the malignant transformation of adenomata of the colon. Dukes (*Brit. J. Surg.*, 13:720, 1925; and *J. Pathol. & Bacteriol.*, 35:323, 1932), Schmiden and Westhues (*Disch. z. Chir.*, 202:1, 1927), Fitz-Gibbon and Rankin (*Surg., Gynec. & Obst.*, 52:1136, 1931) and many other investigators have reported numerous instances of cancerous changes in colonic polypi. It is now believed that cancer of the colon, including the rectum, may be the result of malignant degeneration of adenomata. According to Dukes (1925), simple polypi of the large intestine apparently form as the result of an inborn tendency for groups of cells of the epithelium to undergo hyperplasia, especially in those segments of the bowel which are most exposed to chronic irritation. They are never congenital, but often develop in childhood and new polypi may continue to form throughout life. A single adenoma may be present at a time, but any number may occur clustered together in one spot, and in extreme cases the entire mucous



FIG. 244.—CARCINOMA OF THE TRANSVERSE COLON.

The tumour is undergoing mucoid degeneration. (By courtesy of Mr. Cecil P. G. Wakeley.)

face of the colon may be covered with polypi, the condition then being termed polyposis. Doering (*Arch. f. klin. Chir.*, 83:194, 1907), in a review of 50 cases of polyposis of the colon, found evidence of malignant degeneration in 31 out of the 37 cases which eventually came to autopsy. The tendency to the formation of polypi is often familial.

Carcinoma may also occur as a complication of polyposis which commonly develops in the process of healing in chronic ulcerative colitis. Hurst (*Guy's Hosp. Rep.*, 85:317, 1935) states that most of the polypi are composed of mucous membrane covering inflammatory and granulation tissue, but a minority are true benign adenomata. Polyposis occurred in 10 per cent and malignant degeneration in 2 per cent of the Mayo Clinic series of 693 cases of chronic ulcerative colitis.

PATHOLOGY

Types of Tumour. Carcinoma of the colon has the microscopic structure of columnar-celled adenocarcinoma. In about 5 per cent of cases the tumour undergoes mucoid or colloid degeneration, and mucus-secreting cells are sometimes reproduced in the metastatic deposits (fig. 244).

There are two common macroscopic types of growths:

(1) the proliferative and (2) the annular scirrhus.

The *proliferative* type is most frequently seen in the cæcum and in the ascending colon; it is only rarely observed in the transverse colon or in the distal colon. It forms a fleshy bulky polypoid mass which bulges into the lumen of the bowel (fig. 245). It is a malignant adenoma of slow growth, of a low order of malignancy, and shows no eagerness to metastasise to the regional lymph nodes. The cauliflower-like swelling arises from the wall of the gut from a wide base, showing no tendency at all to encircle the bowel and thus constrict it and produce obstruction. With these right-sided growths, obstruction is always of late occurrence—late because: (a) the proximal colon is capacious; (b) its contents are fluid, and (c) the papilliferous tumour obstructs only in virtue of its great bulk. The surface of the neoplasm finally becomes ulcerated and this may lead to bleeding and predispose to infection. It is, however, improbable that the marked secondary anæmia which is so frequently noticed in cases of cancer of

the proximal colon is due to frank loss of blood. Grave hæmorrhage is an exceedingly rare event, and tests for occult blood are positive in only a minority of cases, possibly not more than 10 to 20 per cent. The cause of this anæmia is quite inexplicable, but it has been suggested that it may be the result of the absorption of noxious toxins from the extensive surface of the growth which, as it ages, is prone to undergo superficial necrotic changes, or of the destruction of some "principle" normally elaborated by the mucosa of the cæcum and ascending colon.

The *annular* type of growth is seen in typical form in the pelvic colon and in the splenic flexure, but it may also arise in the transverse colon or even in the ascending colon a few inches above the ileocæcal valve. It is a small, densely hard, slow-growing tumour which does not project appreciably into the lumen of the bowel but rather tends to encircle the gut wall and constrict it, thus obstructing the passage of solid fæcal matter. The growth leads to a purely localised constriction of the colon—as if a ring encircled the bowel (ring stricture) (fig. 246). When the segment of bowel containing the tumour is slit open it will be seen that the serosa is puckered, infiltrated and drawn inward, that the growth is densely fibrotic in character and that the mucous membrane is little if at all ulcerated. There is but slight longitudinal spread of the growth. Metastases occur late.

Bargen and Rankin (*Ann. Surg.*, 91:583, 1930), in discussing a series of 16 cases of multiple primary carcinomata of the colon, state that the possibility of such multiplicity of lesions should always be borne in mind as it has an important bearing on the prognosis. Primary carcinomata of the stomach and colon may occur simultaneously, and reports of cases successfully treated by partial colectomy and sub-total gastrectomy have been published by Pemberton and Waugh (*Surg.*, 2:211, 1937) and by myself (*Brit. M. J.*, 1:118, 1938).

Methods of Spread. In most cases cancers of the colon grow very tardily. The growth may spread:

1. By direct infiltration of adjacent tissues—spread by continuity.
2. By invasion of the lymphatic vessels and glands.
3. By the blood stream, and thus metastasise to distal sites such as the liver.

At an early stage the growth is limited to the mucous coat and sub-

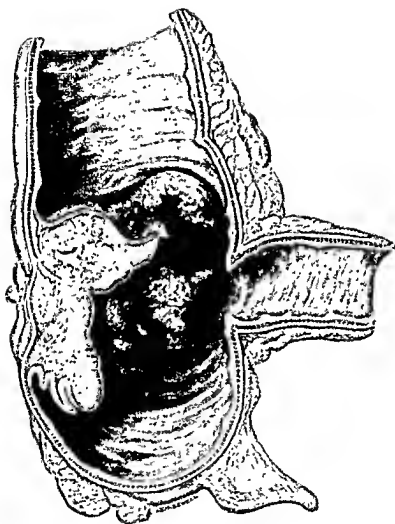


FIG. 245.—CARCINOMA OF THE CÆCUM SHOWING A PROLIFERATIVE TYPE OF GROWTH.

(Cecil P. G. Wakeley.)

mucosa, and shows no inclination to spread longitudinally (except mucoid or colloid cancers) but rather at right angles to the long axis of the bowel. It slowly invades the muscularis and finally bursts through the strong unyielding serosa. The surface of the colon then becomes distorted and discoloured by greyish disc-like masses or small excrescences of pearly growth which may shed and disseminate malignant cells far and wide throughout the peritoneal cavity.



FIG. 246.—ANNULAR STENOSING CARCINOMA OF THE COLON.
(Cecil P. G. Wakeley.)

With the onset of inflammatory changes, the tumour becomes adherent to neighbouring structures such as a loop of the intestine, the uterus, the adnexa or bladder, or becomes fused to the parietes. It should be noted that the bulky types of growth which invade adjacent organs and the tissues of the abdominal wall show but little tendency to metastasise and that radical and perhaps heroic surgery will often lead to spectacular results in such cases. Involvement of the bladder, the uterus, a fallopian tube, or the small intestine is no

bar to radical operation. In a general way it may be stated that in the surgery of the colon there are only two important factors which preclude an extensive extirpation of the growth and its attachments, and these are: Wide peritoneal spread and involvement of the liver with secondary deposits.

Peritoneal spread when limited to a few small nodules near the parent growth need not deter the surgeon from performing a radical operation, but the chances of early recurrence in such cases are, however, very great.

Invasion of the lymphatic vessels and glands is a comparatively late manifestation, and in some 40 per cent of cases it never occurs at all.

"In the proximal part of the colon, with its absorptive function and consequent free lymphatic drainage, lymph involvement is earlier and more extensive than in the distal part of the colon, the function of which is storage the lymph drainage of which is therefore sparse" (Wilkie).

Nevertheless, immediate and late results of operations upon the proximal colon are decidedly more encouraging than those which follow radical procedures upon the distal half. Spread to the liver via the blood stream is fortunately not an early complication in the majority of cases, certainly less so than in cases of cancer of the rectum. It is, however, as Wilkie points out, very prone to occur when the disease affects the distal colon of young patients. On several occasions the first evidence of trouble in such cases has been the appearance of jaundice with marked hepatic enlargement and possibly ascites.

DIAGNOSIS

Signs and Symptoms. The clinical features of cancer of the colon vary according to the type of growth—proliferative or annular, and its situation—in the proximal or distal part of the colon.

In a number of cases the symptoms of carcinoma of the proximal colon may be classified under three main groups:

1. *The Dyspepsia Group.* Here the signs and symptoms point to a mild inflammatory lesion of the gall-bladder or appendix. The most noticeable feature, however, is often a change in bowel habit. Later there is a slight but persistent dyspepsia with some pain and

tenderness felt either beneath the right costal margin or over the cæcum.

2. *The Anæmia Group.* In this group the patients are markedly anæmic, asthenic and toxic. The most striking characteristic is, of course, the anæmia which may be so severe as to resemble that of the pernicious type. A blood count, however, shows that it is a sec-



FIG. 247.—BARIUM ENEMA X-RAY EXAMINATION SHOWING A CARCINOMATOUS LESION AT THE COMMENCEMENT OF THE ASCENDING COLON.

The patient was markedly anæmic and an examination of the blood showed a pronounced secondary anæmia. (Bull.)

ondary microcytic anæmia such as is sometimes associated with severe intoxications. These patients all complain of loss of weight, dyspnoea on exertion, loss of interest, and extreme lassitude. On examination there may be a suspicion of a mass in the right iliac fossa, and a barium enema X-ray examination may reveal a filling defect in the bowel (fig. 247).

3. *The Mass Group.* Here during a routine physical examination a palpable mass is discovered in the right half of the abdomen or in the epigastric region, further investigation proving it to be a malignant lesion.

In the case of carcinoma of the distal colon—the favourite site of ring strictures, there is as a rule little if any evidence of septic absorption, no appreciable loss of weight, no anæmia, no noticeable loss of blood, and no dyspeptic symptoms of any importance, but merely an increasing difficulty in getting the bowels open in a satisfactory manner, some trouble with flatulence, occasional colicky pain associated with intestinal noises, and every now and then following a period of obstinate constipation a day or two of diarrhœa. This state of affairs persists for weeks or months until eventually acute obstruction supervenes. If the growth is situated low down in the pelvic colon there may be occasional tenesmus and the passage of some blood and mucus, and there will in addition be some irregularity in the action of the bowels.

It has been my experience that about 70 to 80 per cent of cases of cancer of the distal colon are admitted to hospital with some degree of obstruction. The late neglected obstructed case with cæcal perforation may be erroneously diagnosed as one of appendicitis with generalised peritonitis.

X-ray examination of the bowel following the administration of a barium enema is unquestionably the most satisfactory single diagnostic aid in respect of growths beyond the view of the sigmoidoscope. It is also of great value, although it is by no means infallible, in the diagnosis of early cases. Cancer of the colon should be suspected more frequently than is the case today. It should be suspected in all patients who suffer from an inexplicable secondary anæmia, in those who show signs of the "fatigue syndrome," in those who suffer from chronic dyspepsia in which investigation of the upper alimentary tract yields negative results, and in those who after the age of 40 develop an irregularity of the bowels associated with flatulence and borborygmi.

In the diagnosis of cancer of the colon three forms of X-ray examination are employed:

1. **Straight X-Ray Examination of the Abdomen.** This is particularly useful in cases of intestinal obstruction, as the pictures may

show gaseous distension of the bowel, ending sharply at the seat of the growth.

2. **Barium Enema.** This may reveal the site of the stricture or obstruction or may show a persistent filling defect (figs. 248 and 249).



FIG. 248.—CARCINOMA OF THE DESCENDING COLON.

(Graham Hodgson.)

3. **Double-Contrast Enema.** By this method the colon is distended with air after a barium enema has been evacuated. It is helpful in showing up growths which project into the lumen of the bowel and

which may previously have been obscured by a dense barium shadow. A barium meal examination should not be employed for the cases under discussion, as the barium mixture may become impacted above an annular growth and thus give rise to obstructive symptoms.



FIG. 249.—CARCINOMA OF THE SIGMOID LOOP.
(Graham Hodgson.)

Sigmoidoscopic Examination. This should be a routine procedure for all patients suspected of harbouring a cancer in the rectum, the rectosigmoid region or the pelvic colon. It may supply the only proof that a growth is present. In some instances when the growth is visualised it may be advisable to remove a small fragment for biopsy.

Examination of the Blood and of the Stools. Here again a complete examination of the blood and of the stools is carried out as a

routine measure. It is a curious fact that in malignant lesions of the right colon, tests for occult blood are negative in over 80 per cent of cases.

DIFFERENTIAL DIAGNOSIS

The following diseases will have to be considered in the differential diagnosis:

1. Hyperplastic tuberculosis of the colon.
2. Polyposis.
3. Diverticulitis.
4. Gunmatous colitis.
5. Actinomycosis of the right iliac fossa.
6. Chronic ulcerative colitis (segmental).
7. Retrocæcal appendicitis.
8. Resolving appendix abscess.
9. Retroperitoneal tumours.
10. Simple ulcer of the large bowel (Kerr, *Lancet*, 2:550, 1935; and Wilkie, *Surg.*, 1:655, 1937).
11. Regional enteritis.
12. Benign tumours of the colon.

PROGNOSIS

The commonest site for carcinoma in both sexes is the gastrointestinal tract, and of all the malignant lesions involving this system those of the colon offer the best prognosis. The prognosis is good because the lesion is relatively benign, it is accessible, it can be eradicated with a wide margin of healthy tissue, the operative death-rate is not high, and statistics show that five-year cures exceed 30 per cent.

OPERABILITY

Ochsner and DeBakey (*Am. J. Surg.*, 46:103, 1939) analysed a series of 4,561 cases of carcinoma of the colon and found that 2,670 (58.5 per cent) were operable. Rankin and Olson (*Surg., Gynec. & Obst.*, 56:366, 1933) state that at the Mayo Clinic the highest operability rate for cancer of the colon was 68 per cent. Geschickter (*Am. J. Cancer*, 25:130, 1935) in his study of 250 cases of cancer of the colon

found that the operability rate was as follows: ascending colon 53 per cent; hepatic flexure 85 per cent; splenic flexure 45 per cent; and descending colon 47 per cent.

The operability of carcinoma of the colon is evidenced also by the post-mortem findings. Larson (*Minnesota Med.*, 18:212, 1935) found that of 210 cases of carcinoma of the colon coming to post-mortem examination, no fewer than 113 had either no metastases at all or only a few small enlarged regional glands which were easily resectable. Harding and Hankins (*Am. J. Cancer*, 17:434, 1933) in 118 post-mortem examinations found no evidence of metastases in 41 per cent, and in an additional 4 per cent the metastases were regarded as slight and these cases would have been amenable to surgical measures.

It will therefore be seen from this last report that in 45 per cent of these fatal cases the lesions *might* have been dealt with by radical operative procedures.

OPERATIVE MORTALITY

Ochsner and DeBakey, from whose comprehensive paper I have borrowed much useful statistical data, point out that in the hands of most abdominal surgeons of experience radical excision of the colon for cancer is associated with a mortality of about 20 per cent. Thus in a series of 2,991 cases collected by them, in which resection of the colon was carried out for cancer, there were 422 (21.7 per cent) deaths. T. E. Jones (*Surg., Gynec. & Obst.*, 62:415, 1936) reported a personal series of 161 cases of partial colectomy for cancer with only 16 deaths (10.5 per cent) and this low death-rate is a direct tribute to this surgeon's fine judgment and skill.

THE DEATH-RATE FOLLOWING RESECTION OF THE PROXIMAL AND DISTAL COLON

Resections of the proximal half of the colon are definitely sater than resections of the distal colon. This is confirmed by the figures of many surgeons including those of Allen, Paus and Rankin. Thus Allen (*J. Am. M. Ass.*, 109:923, 1937) reported 91 cases of right-sided colectomy for cancer with 17 deaths (18.6 per cent) and 169

cases of left-sided resection with 39 deaths (23.8 per cent). Paus (*Acta chir. Scandin.*, 74:457, 1934) published an operative death-rate of 17.1 per cent for right-sided colectomies, as contrasted with 31.1 per cent in left-sided resections. Rankin (*Wisconsin M. J.*, 302, 1932) performed 160 right-sided resections with 4 deaths (8.7 per cent) and 333 left-sided resections with 54 deaths (16.2 per cent).

Resections of the transverse colon for malignant disease are associated with a mortality of about 20 per cent.

LATE RESULTS

A follow-up of cases of malignant disease is, as a rule, a most disheartening exercise. Happily, however, this is not the case with cancer of the colon. The complete restoration to sound health and active life such as had not been enjoyed for many months prior to operation is evidence of the slow and insidious growth of colonic tumours. That the life expectancy following resection of the colon for cancer is good may be appreciated from the series of 3,911 reported resections in which there were 1,204 (30.7 per cent) five-year cures. In a study of 754 cases of cancer of the colon Rankin and Olson (1933) found that the percentage of five-year cures in growths which projected into the lumen of the bowel was 62 per cent as against 41 per cent for tumours that extended toward the serosa, i.e., the annular type.

Pemberton and Dixon (*Surg., Gynec. & Obst.*, 58:462, 1934) published a series of 1,920 cases of resections of the colon for cancer at the Mayo Clinic and found the evidence of five-year cures to be as follows: the cæcum 51.8 per cent; the remaining portion of the colon down to the sigmoid—48.9 per cent; the sigmoid 40.6 per cent; and the rectosigmoid 36.9 per cent. It is thus seen that the incidence of five-year cures decreases proportionately with the distance from the cæcum to the lowest end of the sigmoid loop.

TYPE OF MALIGNANT CELL

The type of malignant cell is of the greatest significance in prognosis. The more immature or primitive the cell, the greater the degree of malignancy and the poorer the outlook. Broders (*Minnesota Med.*, 8:726, 1925) deserves the greatest credit for calling attention

to the importance of grading cancers in the various parts of the body by histological examination. In such a way it is often possible for the pathologist to foretell the issue with an uncanny degree of accuracy in individual cases.

THE INFLUENCE OF OBSTRUCTION

All reports on this subject emphasise that the prognosis is greatly dependent upon the presence or absence of obstruction. There is irrefutable evidence to show that a patient with cancer of the colon without any obstructive symptoms has a much better chance of surviving operation than a patient with cancer of the colon accompanied by obstruction. These patients with obstruction are toxic and dehydrated, the large gut being distended, œdematous, friable and filled with highly noxious substances. To do more than perform a decompression operation, *e.g.*, cœcostomy, on such patients during the acute phase is to court disaster.

ANÆMIA

Marked secondary anæmia associated with lesions of the distal colon is an omen of the gravest diagnostic import. It generally implies that the case is inoperable. This, however, is not so with cancer of the proximal colon, since with growths in this situation even a hæmoglobin concentration of 30 per cent is no bar to radical surgical procedures. Blood transfusion is of course an indispensable pre- and post-operative routine measure in such cases.

AGE

Age influences the prognosis in carcinoma of the colon. Thus, the younger is the patient the more rapid is the growth, the more immature the cell, the more eager its spread via the blood and lymph stream, and the poorer the chance of resection. Conversely, the older is the patient the more localised is the lesion, the more sluggish its growth in all directions, and the greater the chances of its removal. The operative death-rate, however, is higher in those of advanced age. Rankin and Graham (*Cancer of the Colon and Rectum*, 1939)

state that with advancing age metastases are less likely to occur because of the atrophy of the lymphatic channels and nodes.

OBESITY

The fat patient with cancer of the colon is a poor surgical risk. The operative procedure, even though it may be a palliative one, is always a difficult undertaking; the incidence of infection is high; the operability rate is comparatively low, and the prospects of ultimate cure following radical removal are decidedly less hopeful than in thin individuals or in those of normal weight.

OTHER FACTORS IN PROGNOSIS

Additional factors which influence the prognosis are:

1. The measures employed in the pre-operative preparation of the patient.
2. The choice of anæsthetic.
3. The non-operative procedures which are instituted to decompress the colon.
4. The selection of the optimum time for operation as well as the selection of the best surgical procedure for the particular patient.
5. The employment where possible of operations in multiple stages.

A. THE TREATMENT OF CARCINOMA OF THE COLON IN THE PRESENCE OF ACUTE INTESTINAL OBSTRUCTION

This subject has previously been discussed on pages 1089, 1118 and 1198, and some general principles relating to the management of such cases have already been mentioned.

It is now necessary, however, to be more precise with regard to the details of the treatment of these difficult cases. Let us consider a few typical examples:

1. A patient is admitted to hospital suffering from acute intestinal obstruction, clinical and radiological investigations have failed to reveal the cause of the stoppage, and all attempts to decompress the bowel by enemata, etc., have proved unsuccessful.

Here, the abdomen should be opened by a small right para-umbilical or low paramedian incision, large enough to admit two or three fingers. If there is no free blood-stained fluid in the peritoneal cavity and if the cæcum is tensely blown out, after closing the wound a blind valvular cæcostomy should be performed through a small gridiron incision (see fig. 235). No exploration should be conducted and the hand should not in any circumstances be swept among the coils of distended bowel in search of the obstructing lesion.

After a few days when a satisfactory decompression has been achieved by the cæcostomy, a barium enema X-ray examination is carried out to locate the position of the obstruction in the colon. At a second operation the abdomen is methodically explored; the tumour is examined to determine its exact position and its extent and whether or not it is removable; a search is made for enlarged nodes; the liver is palpated for the presence or absence of metastatic deposits, and the pelvis is searched for implants in the pelvic shelf.

It must again be emphasised that spread by contiguity is no bar to radical surgery. Wide peritoneal spread and the presence of secondary deposits in the liver, however, preclude any attempt at cure.

2. The cause of the acute obstruction is known—or at least suspected—to be a cancer of the distal colon.

The preliminary operation in this case is valvular cæcostomy performed through a small right gridiron incision. About ten days or so later, when the patient's general condition shows marked improvement, the abdomen is explored.

3. A patient has a mass in the right iliac fossa and the symptoms of acute obstruction.

The first step in the treatment is decompression of the small intestine. This is best achieved by passing a Miller-Abbott tube into the stomach and by aiding the distal end to find its way to the foul, stagnant semi-solid matter in the lower coils of the ileum so that the intestines can be thoroughly emptied by suction and cleansed as completely as possible by irrigations with warm saline solution.

When the obstructive symptoms have been overcome by this measure, an exploratory laparotomy is conducted to inquire into the nature of the obstructing agent. If the malignant mass proves to be irremovable, as may well be the case, the procedure of choice is side-to-side ileo-transverse colostomy in order to short-circuit the obstruc-

tion. Valvular ileostomy has been suggested as an alternative to decompression by suction-siphonage. My experience of ileostomy in this type of case, however, has been singularly depressing, as in those cases in which it was undertaken the enterostomy tube, after functioning poorly for a day or two and affording little or no relief of the urgent symptoms, soon became clogged with tenacious putty-like faeces which defied all attempts at dislodgment. Should assiduous irrigation by some chance succeed in clearing the lumen of the catheter of its gummy matter, the lumen will rapidly seal up again, cease to function, and the tube become a real menace.

4. A patient has an irremovable growth of the hepatic flexure, associated with obstructive symptoms.

Here the first operation should be a valvular cæcostomy and the second a side-to-side ileo-transverse colostomy.

5. A patient has an inoperable cancerous mass involving the middle third of the transverse colon.

In such a case relief may be afforded by a loop colostomy applied to the mobilised hepatic flexure; or, following a preliminary cæcostomy, by anastomosing a moderately low loop of ileum to some spot in the distal colon well beyond all possible spread of the growth.

Obstructive phenomena associated with carcinomata of the proximal colon are always late manifestations and may consequently spell inoperability. It is a mistake to perform enterostomy on these patients in the hope that this will tide them over the acute phase, and it is also a grave error in judgment to short-circuit the growth in the face of obstruction. The rule here is first to decompress the intestine by an indwelling intestinal tube, and then to re-habilitate the patient before undertaking an exploratory operation. If the malignant mass defies excision, the now-empty and flaccid distal ileum can with safety be joined to the colon.

B. THE TREATMENT OF CARCINOMA OF THE COLON IN WHICH OBSTRUCTION HAS EITHER NOT YET DEVELOPED OR HAS BEEN RELIEVED

Pre-Operative Treatment.—*Medical Measures for Decompressing the Bowel.* The majority of patients admitted to hospital for carcinoma of the colon exhibit some degree of obstruction. Where there-

fore chronic obstruction or even a mild degree of distension is present, the following treatment is instituted:

(a) Daily glycerine enemata.

(b) Magnesium sulphate, 1 drachm hourly for six to eight doses, followed by

(c) Liquid paraffin, 1 oz. three times a day for a few days, and then 1-drachm doses twice daily until the morning of the operation.

(d) Occasional injections of pituitrin, 0.5 to 1 cc., or some other intestinal stimulant.

(e) If there is any vomiting or distension, a duodenal tube should be passed and suction-siphonage attempted.

2. *Diet and Fluids.* (a) The patient should be given a high caloric non-residue diet rich in sugars.

(b) Water balance must be established before operation is performed. Fluids and salts in measured amounts are best administered by mouth, but if vomiting or nausea is present the intravenous route should be chosen.

(c) Vitamins. Vitamins A, B and C, which are usually lacking in these cases, should be amply replaced. Vitamin C deficiency predisposes to infection and to interference with wound healing. Vitamin B is said to exert a definite tonic effect on the colon; while Saitta (*Scruti Biol.*, 5:273, 1930) maintains that deficiency of this vitamin also accounts for the poor healing of wounds. Vitamin B is given in the form of benerva (Roche) by mouth in tablet form, the average dose being two tablets three times a day or by intramuscular injections of 2 to 10 mgms. daily.

3. *Blood Transfusion.* This is given by the drip method in order to combat anæmia, to serve as a pre-operative fillip and to correct hypo-proteinæmia. Thompson, Ravdin and Frank (*Arch. Surg.*, 36:500, 1938), as the result of their investigations, have shown that in the presence of a definite lack of plasma proteins there is a pronounced interference with wound healing.

4. *Peritoneal Vaccination.* Wilkie, who was the originator of peritoneal vaccination, makes the following remarks on this subject, which are of historical interest:

Mikulicz (1905), tackling the problem from the systemic aspect, gave a subcutaneous injection of nucleic acid the night before a colon operation to produce a leucocytosis. In *The Medical Chronicle*, 1910, I advocated the combined

use of pre-operative inoculation with vaccine of virulent streptococci and *Bac. coli*, with the stimulation of a pre-operative leucocytosis by the subcutaneous injection of sodium nucleinate the night before operation. Two inoculations were given, one eight days and one three days before operation. The patient thus came to operation with antibodies in his blood and with a mild leucocytosis, i.e., with his tissues on guard against infection. I have used this method now for twenty-eight years and am convinced of its value. Of late years Dixon (1936) and also Rankin (1934), both at that time in the Mayo Clinic, advocated giving the vaccine intra-peritoneally, combining the principles of increased resistance by peritoneal irritation and of active immunity by inoculation.¹

Ochsner and DeBakey (1939) state that although Dixon is still an enthusiastic supporter of this method of therapy

Rankin, who was an ardent advocate of the use of vaccine, as evidenced by reports in 1932 and 1934, more recently (1936) has discontinued to use a vaccine and believes that the decrease in the mortality-rate as previously reported was not due to the use of vaccine but was due to the re-habilitation of the patient and appropriate decompression of the bowel prior to operation. He reports 130 cases with only 11 deaths (8.4 per cent) without the use of a vaccine.

All our experience is similar to that of Collier and we feel that the pre-operative vaccination is not only unnecessary but undesirable because should accidental spillage occur at the time of operation gross infection of the peritoneum can be largely obviated by the use of the Steinberg coli bacitracin. Obviously, no vaccine will ever take the place of clean surgery, a point which cannot be over-emphasised.²

Choice of Anæsthetic. The operation of blind cæcostomy is best performed under local anæsthesia. For an operation to resect the colon, spinal anæsthesia is the method of choice as the complete relaxation which results permit of an easy mobilisation of the colon without dragging and without excessive retraction. Spinal anæsthesia is contra-indicated in patients who are seriously ill and toxic, as well as in those who have a low blood pressure. If an inhalation anæsthetic is chosen, the stomach must be thoroughly aspirated immediately before the induction.

¹ Wilkie.

² Ochsner and DeBakey, 1939.

CHOICE OF OPERATION

Operable Cases.—1. *Carcinoma of the Cæcum, Ascending Colon and Hepatic Flexure.* (a) Right hemi-colectomy in two stages by the modified Mikulicz plan—Lahey's extraperitoneal method.

(b) Right hemi-colectomy in one stage—primary resection and primary anastomosis.

(c) Right hemi-colectomy in two stages—intraperitoneal method.

2. *Carcinoma of the Transverse Colon.* (a) Mikulicz resection.

(b) Rankin's method of obstructive resection.

3. *Carcinoma of the Splenic Flexure.* Mikulicz resection.

4. *Carcinoma of the Descending Colon.* (a) Mikulicz resection.
(b) Devine's method.

5. *Carcinoma of the Sigmoid Colon.* (a) Mikulicz resection.
(b) Devine's method.

Inoperable Cases.—1. *Carcinoma of the Proximal Colon.* Side-to-side ileo-colostomy to short-circuit the growth.

2. *Carcinoma of the Distal Colon.* Colostomy.

TECHNIQUE OF THE OPERATIONS

I. **Mikulicz Resection.** "It has been claimed for Mikulicz, whose brow wore many laurels. . . ." (Moynihan).

Köhler (*Zentralbl. f. Chir.*, 50:794, 1881) was the first surgeon to record the successful resection of a malignant tumour of the colon. Following this a few cases were reported from Billroth's clinic, and before 1889 seventeen cases were recorded with a death-rate of approximately 60 per cent. By the end of 1899 the number of reported cases had risen to 57, and in this series there were 19 operative deaths—a mortality of 37 per cent. Over 60 per cent of the deaths following operation were due, as is the case today, to peritonitis, the infection taking place either during the conduct of the operation or from leakage or necrosis at the suture line of the bowel about five to ten days afterward. A determined attempt was made to reduce the mortality of primary resection and primary anastomosis, first by using multiple rows of sutures introduced with the greatest care; then by employing the bone-bobbin or the Murphy button (*Med. Rec.*, 43:665, 1892); then by reverting to simpler methods of anastomosis

and so-called "aseptic" junctions; then by the addition of a prophylactic cæcostomy or colostomy to relieve the strain on the sutured ends of the bowel; and then finally by the two-stage extraperitoneal operation. By this two-stage extraperitoneal method of resection the cancerous growth is brought out on to the surface of the abdomen, and, after approximating the peritoneum and the layers of the abdominal wall around the two issuing limbs of the loop, the tumour is amputated and some time later on, after cutting through the spur with an enterotome, the continuity of the colon is re-established.

An interesting history is attached to this method, the credit in Great Britain having for many years gone to Paul of Liverpool (*Brit. M. J.*, 1:1139, 1895) and in Central Europe to Mikulicz (*Arch. f. klin. Chir.*, 69:1903; and *Boston M. and S. J.*, 148:608, 1903). Neither of these two famous surgeons was the first either to suggest, to publish or to perform this method. Heinecke, in 1890, in his book on operative surgery, described this method of "Vor-lagerung und extraperitoneal Resektion," but published no case in which he had performed it. Bloch of Copenhagen (*Zentralbl. f. Chn.*, 19:628, 1892; and *Nord. med. Ark.*, 1:8, 1892) recorded the first extraperitoneal resection of a carcinoma of the colon in 1892, and published a successful case two years later (*Hospital stid.*, 2:1053, 1894). Allingham (*Tr. Chir. Clin. Soc. Lond.*, 26:140, 1893) and Edmunds (*Tr. Chir. Soc. Lond.*, 27:6, 1894) independently reported certain cases, while others were reported by Hahn (*Berl. klin. Wchnschr.*, 11:276, 1894), by Hochenegg (*Wien. klin. Wchnschr.*, 16:238, 1895) and by Rotter (*Berl. klin. Wchnschr.*, 11:1894). Caird (*Edinb. M. J.*, Oct., 311, 1895) recorded a successful case, and in the same year Paul published his classical paper in the *British Medical Journal*, recording his first case treated by this method. Wilkie states that his clear, concise yet complete description of the method might with advantage be transferred to any modern text-book on operative surgery. Mikulicz performed his first two-stage extraperitoneal resection for carcinoma of the colon in 1898, but did not publish his paper until 1903. Mikulicz was fully aware of the work of Bloch, and had obviously studied the papers of Allingham and Edmunds, for in his article to the *Boston Medical and Surgical Journal* in 1903 he makes these statements: "For this reason Bloch as early as 1892 advocated operating in selected

cases in two sittings." Again: "Allingham and E. Edmunds also have divided the operation in special cases."

Both Paul and Mikulicz emphasised the same points in the operation, namely: (1) the mobilisation of the tumour; (2) V-excision of the mesocolon so that the regional lymphatic vessels and nodes can be removed *en bloc* with the tumour; (3) the approximation of the cut margins of the mesocolon so that no gap remains; (4) the suturing together of the two limbs of the mobilised loop; (5) the stitching of the peritoneum and the other layers of the abdominal incision around the issuing limbs of the bowel; (6) the division of the proximal and distal limbs of the colon one inch or so above the margin of the skin to allow of subsequent retraction; (7) the cutting through of the spur with an enterotome when the abdominal wound is soundly healed, and (8) the closure of the artificial anus by a small extraperitoneal operation.

Although the primary credit for this method should go to Heinecke, Bloch and Paul, today in practically every clinic in the world it is associated with the name of Mikulicz. It was probably Mikulicz's lucid lectures and papers and his capable advocacy of the two-stage extraperitoneal procedure, coupled with his great popularity and fame as a surgeon, which led to his name being attached to this ingenious and safe operation. Credit should also go to a number of modern surgeons who have done much to simplify the operation and to eliminate some of the dangerous points in technique.

There are some who criticise the Mikulicz plan on these grounds:

That the removal of colon and adjacent mesentery effected by this method is neither so liberal nor so radical as obtains in the case of primary resection and primary suture. Also that the percentage of post-operative recurrences is greater after the employment of this procedure.

That for a period of at least two months the bulk of the faecal stream is discharged on to the abdominal wall which often becomes inflamed and excoriated over a wide area.

That convalescence is unduly protracted and that another operation, which may be difficult and unsuccessful, is required to close the faecal fistula.

That the operative death-rate is not materially reduced by the employment of this method.

I think it can be justly stated that the modified Mikulicz operation, as performed today, is not only applicable to malignant lesions of the colon in all locations from the last loop of the ileum to the lowest portion of the sigmoid flexure, but it can be carried out in such a manner that it is in every respect as thorough and as radical as primary removal and primary suture. The resulting single stoma which remains in the abdominal wound after the spur between the two limbs of bowel has been effectively cut through with an enterotome can be successfully closed in every instance with little or no risk by a simple extraperitoneal procedure. In over 200 operations on the modified Mikulicz plan Lahey did not have a single case in which secondary closure of the colonic stoma showed any signs of failure.

It is true that convalescence is protracted and that during the interval between the first and second operations some distress is occasioned by the discharge of fecal matter on to the skin of the abdominal wall; but this is the price the patient has to pay for added security. The commonest cause of death following resection of the colon is peritonitis, and the Mikulicz plan almost entirely eliminates this lethal complication.

We now possess abundant statistical evidence that the Mikulicz procedure is associated with a considerably lower operative mortality than is the operation of primary resection and primary suture. Gordon-Watson (*Practitioner*, 136:121, 1936) and Cattell (*Proc. Inter-State Post-Grad. Med. Assembly N. Am.*, Oct., 1938) agree that multiple-stage operations reduce the death-rate by 50 per cent. The trend of modern practice in the management of these cases may be gauged by the fact that no removal of carcinoma of the colon with immediate primary suture has been undertaken in the Lahey Clinic now for over ten years.

The technique of the Modified Mikulicz Operation for Growths of the Proximal Colon—Lahey's Method. This operation is applicable to growths of the cæcum, ascending colon and hepatic flexure of the large bowel. The technique here described is based on Lahey's original description (*Surg., Gynec. & Obst.*, 54:923, 1932) and also incorporates his latest observations (*Am. J. Surg.*, 46:3, 1939) on the technical details of the operation.

The abdomen is opened through a right paramedian incision or through an incision which vertically divides the right rectus muscle

at the junction of its inner and middle thirds. Cellophane or mackintosh squares are attached to the skin margins and to the cut edges of the peritoneum, and the wound is carefully packed off with large gauze swabs which are placed at the top of the waterproof sheets. The tumour is examined and if resection is feasible the cæcum and ascending colon are drawn through the wound and pulled over toward the middle line, the lateral margin of the wound being at the same time firmly retracted outward. The now taut posterior parietal peritoneum and outer side of the ascending colon is incised about 1 to 1½ inches lateral to the margin of the bowel and this incision is carried upward around the hepatic flexure and downward below the cæcum. The inner edge of the peritoneum is stripped medialward, the fingers, covered with gauze, separating the parts readily. A few stout bands of fascia propria may need division with scissors as the hepatic flexure and the curved transverse colon are reached. The process of stripping is carried inward, well behind the ascending colon and hepatic flexure, until the middle line is reached and the colon is seen to hang loosely by its mesenteric leaf with its contained blood vessels and lymphatic structures.

This ingenious method of mobilisation of the large bowel, to which Kocher, W. J. Mayo and Moynihan first called attention, has greatly simplified the operation of colectomy. The tumour together with a wide margin of intestine and adjacent mesentery can be quickly excised and the proximal and distal loops of bowel can then be laid side by side without the slightest degree of tension.

As the colon is wiped inward, the spermatic blood vessels or the ovarian artery and vein are seen and protected from any injury. The ureter, which is adherent to the parietal peritoneum, is displayed and cautiously pushed aside out of harm's way. As the hepatic flexure is dissected free, the bared duodenum is exposed. Lahey (1939) at this stage gives the following instructions:

When the retro-peritoneal duodenum has been wiped off the root of the mesentery, the mesentery and the distal ileum is then exposed and ligated down to its root, carrying this ligation along the root of the mesentery and the ascending colon up to the point where the transection of the colon at the transverse colon is to take place. Care should be taken to leave a small apron of mesentery at its root over the mesenteric vessels, the aorta, and the vena cava, to protect these structures. This small apron of peritoneum at the root

of the mesentery likewise will provide a flap to suture to the apex of the triangle of mesentery removed with the ascending colon and hepatic flexure. When the mesentery of the ileum is ligated, about 1 inches of the ileum is detached from its mesentery so that it is completely devascularised. This represents the portion of ileum which is to be staggered, the term which I employed in my original description of this plan. This will provide a spigot of devascularised ileum sticking out beyond the abdominal wall, into which a glass tube may immediately be inserted after the operation. This secures immediate decompression of the intestinal tract as soon as the operation is completed.²

As soon as the mesentery of the ileum, ascending colon and hepatic flexure have been tied off and divided, two crushing clamps are applied to the ileum at a point where it is to be cut across, and two more clamps are applied on the transverse colon at a point where it is to be transected. The bowel between these two pairs of clamps is divided with a cautery and the specimen containing the growth, the last few inches of the ileum, the cæcum, the ascending colon, the hepatic flexure and about one-third of the proximal portion of the transverse colon, together with a wide margin of mesentery are removed.

The end of the transverse colon embraced by the enterotome is pulled upward and outward through the wound and the last 12 inches of the ileum is placed alongside the transverse colon in such a manner that 4 inches of devascularised small intestine and fully 1 inch of adjacent normal ileum project vertically beyond the margin of the clamp which is steadying the colon.

The big V-rent in the mesentery is then closed with a running suture of catgut, care being taken not to puncture any blood vessel while inserting this stitch. The anti-mesenteric border of the ileum is then sutured to a longitudinal band of the transverse colon for a distance of 7 inches by a series of closely-applied interrupted sutures so as to ensure a long spur. When this approximation is completed, it will be seen that some 5 to 6 inches of ileum (including 4 inches of devascularised ileum) project beyond the level of the cut end of the transverse colon.

The omentum is wrapped around the double-barrelled ileum and transverse colon, and the two limbs of intestine are implanted into the wound, which is then carefully closed in layers. Neither the

² Lahey, 1939.

ileum nor the transverse colon is sutured to the parietal peritoneum or to any other layer of the abdominal wound, since if this is done there is danger of perforation of the bowel from the sutures being dragged upon or cutting out. Such a perforation might inevitably produce a spreading peritonitis or a diffuse cellulitis of the abdominal wall.

The clamp on the cut end of the transverse colon is strapped to the belly. It exerts an upward traction on the two loops, it prevents retraction of the double-barrelled tube and remains in position sufficiently long (about six days) for the issuing limbs of bowel to become firmly adherent to the wound and parietal peritoneum. The clamp on the end of the ileum is removed at the completion of the operation and a glass tube is passed into the lumen of the devascularised staggered intestine and tied in position. This glass tube is connected to a rubber tube which is led to a bottle beside the bed, thus accomplishing decompression of the intestinal tract.

After four or five days the excess of devascularised staggered loop of ileum sloughs off and the end of the ileum will then be on the same level in the wound as the end of the transverse colon. A day or two later an enterotome is applied to the spur and this crushes its way through in four or five days. The stoma is then examined with the finger to ascertain whether a sufficient amount of spur has been cut down, and if the connecting channel is found to be too short the enterotome should once again be applied to the remaining portion of the spur. As soon as the spur has been obliterated some feces pass on and are evacuated per rectum, but a considerable amount of the irritating ileal contents still pours out through the stoma. A frequent change of dressings will be required and the skin of the abdomen should be protected with aluminium paste or substance of like character.

When the wound is healed, the patient is sent home for a period of two months, and at the end of this time is re-admitted to hospital for the closure of the fecal fistula. This is accomplished in the following manner: An incision is made in the skin, $\frac{1}{4}$ inch away from the margin and completely around the stoma so as to encircle it. This incision is cautiously deepened through the subcutaneous tissues down to the dense aponeurosis of the rectus muscle. If the patient has a thick layer of subcutaneous fat, the dissection need

proceed no further than the rectus sheath, and after trimming away the adherent rim of skin the end of the bowel is turned in with a Connell suture and the suture line reinforced with a few mattress stitches of fine catgut. If the patient is thin, the aponeurosis (fascia) and rectus muscle should in addition be separated from the bowel forming the colostomy. While effecting this separation, care is taken not to buttonhole the bowel or to open the peritoneal cavity. A finger inserted into the colostomy to act as a guide will prove of considerable help during the dissection. All indurated tabs of fat, pieces of mesentery, fascia, skin, muscle and the like, should be carefully cut away so as to make the tube as soft and flexible as possible before it is closed by the catgut sutures. Small rubber drains are placed in the upper and lower ends of the incision, the fatty layer of the abdominal wall is approximated over the suture line in the bowel, and the skin margins are then closed with interrupted stitches.

The operation of resection of the proximal colon by the one-stage or by the two-stage intraperitoneal method, *i.e.*, primary anastomosis followed by resection, is described and illustrated in some detail on page 1207.

The Technique of the Mikulicz Resection for a Growth of the Middle Third of the Transverse Colon. The exploration is conducted through a vertical right epigastric muscle-splitting incision and the tumour is drawn through the wound and examined. If the growth is removable, the first step in the operation is to deal with the gastro-colic omentum. In some cases the growth will have infiltrated this structure sufficiently to necessitate the ligation of the right and left gastro-epiploic blood vessels as near to the greater curvature as possible so that the whole of the vascular epiploic arch, together with the great omentum, can be completely detached from the stomach and removed *en masse* with the malignancy. If the greater curvature of the stomach is involved, a wide V-shaped area of the gastric wall (with its base at the greater curvature) should be cut away while in certain cases even partial gastrectomy may be required (see fig. 250).

After the great omentum has been detached from the proximal and distal thirds of the transverse colon, and the hepatic and splenic flexures completely mobilised, the middle colic artery is tied with two strong silk sutures placed 1 inch apart and as close to its origin

as possible (fig. 251). This artery is then divided and a wide V of mesocolon, with its base remaining attached to the bowel, is cut free. The lateral margins of the mesocolon are then approximated with a running catgut suture, after which the growth together with



FIG. 250 — OPERATION SPECIMEN SHOWING A LARGE PORTION OF THE TRANSVERSE COLON IN THE CENTRE OF WHICH THERE IS A CONSTRICTING MALIGNANT MASS, THE MAJOR PORTION OF THE GREAT OMENTUM, AND A FAIR-SIZED SEGMENT OF THE STOMACH WHICH WAS INVOLVED IN THE GROWTH.

(Mr. Cecil P. G. Wakeley's case.)

the entire transverse colon and its attached portion of mesocolon and the whole of the great omentum are drawn firmly through the abdominal wound. The proximal and distal segments of colon are approximated for a distance of 5 or 6 inches with a series of inter-

rupted catgut stitches which pick up corresponding points on the longitudinal bands. The issuing loops should be so arranged that they lie side by side, *i.e.*, one to the right and the other to the left of the skin incision, and, in order that they may be accommodated snugly in the wound when it is sutured about them, the margins of the fascia and rectus muscle should be cut through transversely at their point of emergence.

After the incision has been closed and protected with adhesive waterproof sheets, the proximal (right) and the distal (left) limbs of colon are crushed in the jaws of a Rankin clamp, about 2 inches above the margin of the skin (fig. 252). Enterotomes are now applied to the loops just clear of the Rankin clamp, the bowel is burned through with a cautery, and the specimen is removed (see fig. 250). Gauze swabs are placed beneath the three-bladed clamp, the handle of which points toward the pubes and the tips toward the chin. The clamp is then securely anchored to the abdominal wall with strips of adhesive plaster.

Rankin (*Surgery of the Colon*, 1926) advises that the clamp which embraces the proximal end of the right colon should be left in situ for two or three days (obstructive resection) and that the one attached to the end of the distal or left stump should be allowed to remain until it sloughs through. However, at the end of twenty-four hours when the protected wound is partially sealed off, I insert a purse-string suture proximal to the obstructing clamp, puncture the bowel with a cautery, and introduce a rubber catheter, thus affording relief of gaseous distension without having to take off the clamp. At the end of three or four days I release or detach the clamp on the proximal end of the colon and allow the feces to pass on to the skin of the abdominal wall; three days after this the distal clamp cuts out.

When the wound is healed and there is no fever, the long colonic spur is crushed with a DeBakey-Ochsner clamp (*Surg.*, 5:947, 1939), or if this instrument is not available, a Mikulicz, a Devine or a Wakeley enterotome is used. I have on a number of occasions successfully employed large-sized Kocher artery forceps when ablating the spur, but it is usually necessary to take two separate bites with this instrument before a sufficient amount of spur has been cut down. The moment the spur has been destroyed, a large quantity of feces

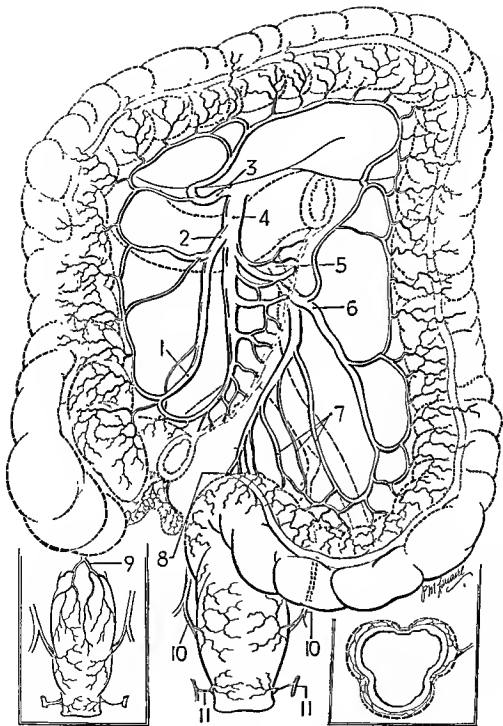


FIG. 251.—THE ARTERIAL SUPPLY OF THE COLON AND RECTUM.

will pass per rectum, but an appreciable amount will also pass through the colostomy opening on to the skin.

The patient is fitted with a suitable belt and sent home for two months. He is then re-admitted to hospital for closure of the fæcal fistula. By this time the stoma will have shrunk considerably, the skin condition around the opening will show definite signs of toleration, and the patient's general condition will often occasion the greatest satisfaction to all concerned.

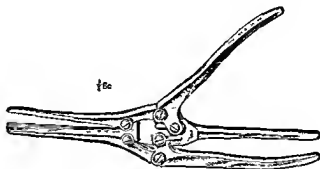


FIG. 252.—THE RANKIN CLAMP.

As previously stated, the extraperitoneal closure of the colostomy is a simple affair, provided no pieces of omentum, mesocolon or fatty tags have been left clinging to the bowel at the first operation. A second incision encircles the stoma, the tube of bowel is dissected free (with a finger in the colostomy) from the surrounding fatty layers, fascia and muscle down to the now firmly adherent parietal peritoneum, and the margin of the opening is neatly trimmed and then closed with a Connell suture which is reinforced with a series of Halsted stitches of fine chromic catgut.

FIGURE 251 (opposite).

1. Ileo-colic artery.
2. Ileo-colic artery giving off the right colic artery.
3. Middle colic artery.
4. Superior mesenteric artery.
5. Inferior mesenteric artery.
6. Left colic artery.
7. Sigmoidal branches of the inferior mesenteric artery.
- 8 and 9. Superior hæmorrhoidal artery.
10. Middle hæmorrhoidal artery.
11. Inferior hæmorrhoidal artery.

All that now remains to be done is to approximate the freed layers of the abdominal wall one by one over the sutured intestine and to provide drainage for the subcutaneous tissues.

The Mikulicz Plan for Cancer of the Splenic Flexure. In removing a tumour in this region it is necessary to take away one third or one half of the transverse colon and the whole of the descending colon. The incision starts at the left costal margin, $1\frac{1}{2}$ to 2 inches from the midline, and extends downward at the junction of the inner and middle thirds of the left rectus muscle, to a point 1 inch below the umbilicus. The rectus muscle is split longitudinally, the peritoneum is opened, and the lateral margin of the wound is firmly retracted outward.

The operation begins with the detachment of the great omentum from the left half of the transverse colon, followed by division of the parietal peritoneum on the lateral aspect of the descending colon; the incision is then carried round the splenic flexure, the costo-colic ligament being snipped through with scissors, and the lowest portions of the gastro-splenic and gastro-colic omenta are divided. A little blunt dissection is now necessary to free the splenic flexure, to raise it from its bed, and to mobilise it freely so that it can be delivered through the wound.

This part of the operation is very difficult, and unless great care is taken sharp hæmorrhage may be started from a tear in the spleen, the stomach or the vessels in the gastro-splenic omentum. The descending colon and part of the sigmoid flexure are swept inward toward the middle line until the whole angle of bowel with the growth at its apex can be turned well over to the right to display the left colic artery and its anastomosis with the middle colic artery. The ascending branch of the left colic artery is tied off with two ligatures, and divided between them. From this point two incisions are made in the mesentery, one directly upward toward the junction of the middle and outer thirds of the transverse colon (which encounters the middle colic artery on its way to the anastomosis of Riolan) and the other at a point on the descending colon which has been selected for transection (see fig. 251). The bowel at each end is divided with a cautery between enterotomes.

Lahey emphasizes a very important point in technique and one which is not generally recognised. He writes:

In resections of the splenic flexures one must be careful in removing the mesentery lest too radical removal take one down to the point where the jejunum becomes retro peritoneal. One must be careful also to leave an apron of mesenteric peritoneum above the jejunal fossa. The peritoneum here is extremely friable and, if the dissection is carried down to the point where the jejunum becomes retro-peritoneal, it will be almost impossible to reconstruct with security this peritoneal covering about the point where the jejunum becomes retro-peritoneal. It is very much better to leave three or four inches of mesenteric peritoneum around the opening in the jejunal fossa in order to avoid this danger.⁴

The margins of the mesentery are now sutured together with a continuous suture and the two barrels of colon, after being laid side by side, are united with a series of interrupted sutures. The wound is snugly closed around the issuing limbs of colon, the ends of which are embraced in clamps which are fastened to the abdominal wall.

The subsequent management of these cases is the same as that detailed under the operation just described.

There are a number of recorded cases in which the growth has extended posteriorly and invaded the splenic substance, the left kidney or the ureter, and in which the surgeon has been compelled to remove the spleen or the kidney together with the carcinoma in an attempt to save the patient's life. In 1922 I operated upon an obese young woman who had a large bulky malignant lesion involving the upper end of the descending colon. The growth was fixed posteriorly and on mobilising the bowel the lower pole of the left kidney and the ureter were seen to be firmly rooted to the neoplasm. After ligating and dividing the renal vessels and the lower end of the ureter, the mobilised colon together with the heterogeneous cancerous mass was widely excised and I did then what I would not do now, namely, a primary anastomosis supplemented by a cæcostomy. The patient had a stormy convalescence, and the abdominal wound broke down and discharged fæces in a constant stream. The fæcal fistula reluctantly closed and she was discharged from hospital with a ventral hernia. Some happy thought brought her to see me fifteen years later when she looked the picture of health; but the rupture was still there.

Mikulicz Resection of a Growth in the Descending Colon. In this case the essential steps of the operation are similar to those just described. The left colic artery is ligatured and the first sigmoidal

⁴ Lahey, *Surg. Clin. N. Am.*, 19 639, 1939. Courtesy of W. B. Saunders Co.

artery is tied; the outer third of the transverse colon, the splenic flexure, the descending colon and the proximal half of the sigmoid loop are removed together with a generous wedge of mesentery; the edges of the mesentery are drawn together; a double-barrelled tube is fashioned and implanted into the wound 2 inches above the level of the skin; the ends of the proximal and distal limbs are embraced in enterotomes or a Rankin clamp, and when the clamps are removed the spur is crushed through. The colostomy stoma is closed two months later in the manner already described.



FIG. 253 —MIKULICZ RESECTION OF A GROWTH IN THE SIGMOID COLON.

The bowel is being mobilised by division of the posterior parietal peritoneum about one inch lateral to the origin of the meso-sigmoid. Note the position of the ureter.

Mikulicz Resection of a Growth in the Sigmoid Flexure. Through a long left transrectus incision or preferably through an oblique muscle-cutting incision, the whole of the sigmoid colon, the descending colon and the splenic flexure are loosened. To effect this mobilisation an incision is made in the posterior parietal peritoneum about 1 inch lateral to the origin of the mesosigmoid and this incision is carried upward along the outer side of the descending colon, around the splenic flexure and then downward well over the brim of the

pelvis to the left side of the upper portion of the rectum (fig. 253). The distal colon is now swept inward toward the middle line by gauze dissection until it hangs loosely by its thin transparent mesenteric leaf and long arching blood vessels. As the bowel is held up to the light, the details of the vascular distribution can be clearly made out. The ureter and the spermatic or ovarian vessels are seen during this dissection, and care is taken to avoid any injury to them. The

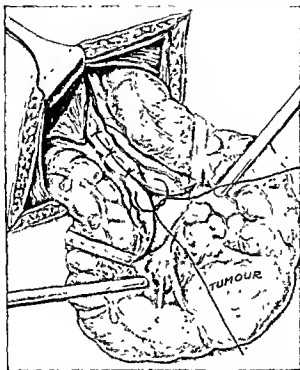


FIG. 254.—MIKULICZ RESECTION OF A GROWTH IN THE SIGMOID COLON.

The margins of the mesentery are being approximated with a series of interrupted sutures.

left colic artery or its main descending branch is tied off and divided; the upper two sigmoidal vessels are ligatured; a wedge-shaped portion of the mesentery containing the lymphatic area of the growth is cut through, leaving its broad base attached to the bowel; the wedge gap in the mesentery is closed with a continuous stitch of catgut, and after approximating the two limbs of bowel which will eventually become a single colostomy tube, the operation proceeds in the manner already described (figs. 254, 255 and 256).



FIG. 255.—MIKULICZ RESECTION OF A GROWTH IN THE SIGMOID COLON.

The issuing limbs of colon are being approximated with a series of interrupted sutures.

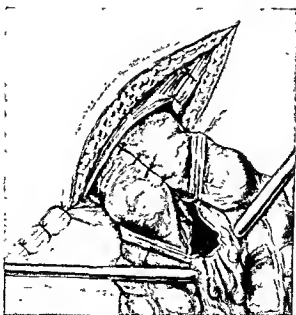


FIG. 256.—MIKULICZ RESECTION OF A GROWTH IN THE SIGMOID COLON.

The loop of sigmoid containing the growth and a wide margin of mesentery are about to be excised.

I sometimes tie a rubber tube into the proximal stump at the completion of the operation to effect an immediate decompression of the bowel; but the distal clamp remains in situ until it cuts out about six or seven days later (fig. 257).

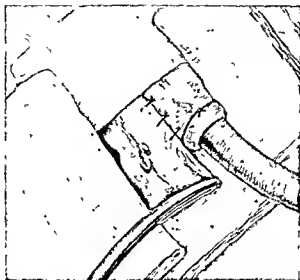


FIG. 257.—MIKULICZ RESECTION OF A GROWTH IN THE SIGMOID COLON

A rubber tube has been tied into the proximal limb of the colon while the distal limb is being steadied with a clamp. Note how the wound is carefully packed off with water-proof sheets.

When the wound has healed and the clamps are off, it will be noted that at least 2 inches of the proximal and distal colon project beyond the skin margin. The crushing of the spur and the closure of the colostomy do not differ in any respect from the methods previously detailed (figs. 258 and 259).

Zachary Cope (*Brit. M. J.*, 1:143, 1940), in a summary of the Mikulicz plan, points out that for a malignant lesion of the colon no procedure is so likely to be followed by success as an extra-peritoneal resection based on Mikulicz's method, provided always that extreme distension has been previously overcome by a cæcostomy or colostomy. He has adopted this method during the last seven years for all cases of resection of the colon (any part of which with the exception of the lowest part of the sigmoid colon may be treated in this manner) and he has used a few special instruments which he considers make the operation an easier matter.

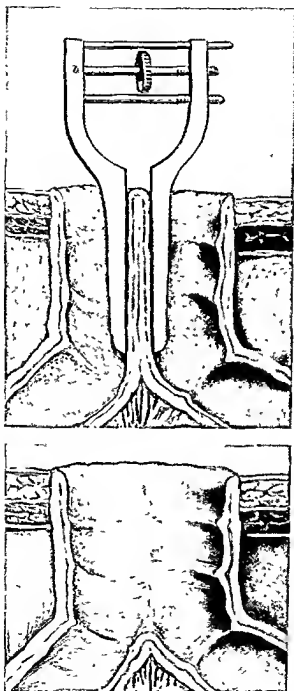


FIG. 258.—MIKULICZ RESECTION OF A GROWTH IN THE SIGMOID COLON.
The method of destroying the spur with a DeBakey-Ochsner clamp.

By his technique, after the bowel has been freely mobilised through an ample incision, it is drawn out of the abdominal cavity and its mesentery ligatured off in sections at the base of the coil so as to remove all the lymphatic structures which might be implicated. Special care is taken to see that the base of the coil has a good blood supply so that the division of the bowel can be carried out without any fear of subsequent necrosis. The hole in the mesentery is now

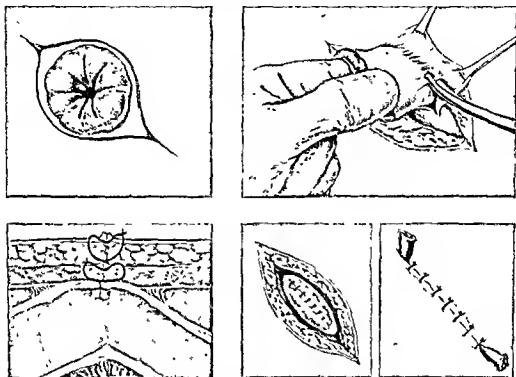


FIG. 259.—MIKULICZ RESECTION OF A GROWTH IN THE SIGMOID COLON.

Extra peritoneal closure of the colostomy stoma.

closed and the parietal peritoneum is sewn by a few stitches to the afferent and efferent limbs of the coil and the wound is approximated, leaving enough room for the bowel to pass through the opening without being constricted.

The bowel spur is now crushed at the determined place by means of a powerful crushing clamp with three blades (Cope's modification of the de Martel clamp) (fig. 260), and divided by a cautery after removing the middle blade. Each end of the bowel can

be manipulated easily by grasping the blade which occludes it. The two stumps are laid side by side and the contiguous portions of the bowel are sutured together on the side away from the mesentery. The abdominal wound is protected by rubber gauze or gauze soaked in

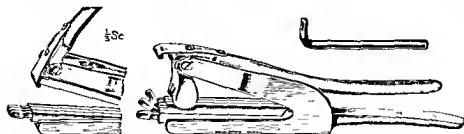


FIG. 260.—COPE'S MODIFICATION OF THE DE MARTEL CLAMP.

acridlavine solution before opening the ends and inserting the two special tubes (fig. 261). These tubes are made of metal and are of unequal calibre. When dealing with the left side of the colon the larger tube is introduced into the proximal end of the bowel, but in

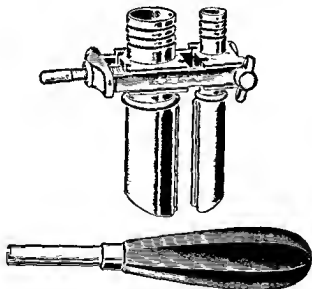


FIG. 261.—COPE'S SPECIAL TUBES AND ENTERTOME, AS USED BY HIM IN PERFORMING THE MIKULICZ OPERATION.

resections of the lower end of the ileum and proximal colon the smaller tube is inserted into the open end of the ileum and the larger into the distal end of the colon. The tubes are fixed in position by

strong silk which is stitched round the end of the bowel and tied tightly into the groove made for it on the metal tube. The external ends of the tubes are then fitted into a metal gate by means of which they can be approximated and pressed together by screw pressure. On one tube there is a raised ridge, and on the other a linear depression. They are placed in the gate in such a way that the ridge fits into the depression and gradually brings about linear necrosis. A rubber tube is attached to the end of the proximal tube. The tip ends of the tube are made oblique to avoid damage to the gut. Each day after operation the screw is slightly turned and the pressure increased. The tubes generally cut through the spur and come away in five or six days, leaving one wide colostomy opening. The stoma is closed by the extraperitoneal method when all the œdema and thickening around the artificial anus have disappeared.

Cope has treated 17 patients with carcinoma of the colon by this method and all but one made a good recovery in spite of the fact that some were feeble and elderly subjects.

CONCLUSIONS

1. The modified Mikulicz procedure may be applied to malignant growths at any level of the colon from the last loop of the ileum to the lower portion of the sigmoid flexure.

2. Just as radical an excision of the colon and mesentery can be effected by the Mikulicz method as can be accomplished by any other operative procedure such as primary resection and primary anastomosis.

3. The operative death-rate of the Mikulicz operation is unquestionably lower than that of primary resection and primary anastomosis, and the late results in so far as cure is concerned are equally as good.

II. Operations upon the Defunctioned Distal Colon by the Methods of Devine. "I felt that if I could deprive the distal colon of its function, remove its contents, let it lie dormant for sometime until it had lost a good deal of its germ content, just as an isolated experimental loop loses its organisms, I could carry out any operation on it and get just as good repair in it as I would in any other part of the intestinal canal" (Devine).

During the last six years this gifted Australian surgeon has published many articles (*Med. Press & Circ.*, 190:111, 1935; *Brit. M. J.*, 2:1245, 1935; *Brit. J. Surg.*, 25:351, 1937; and *Surg.*, 3:165, 1938), describing his method of defunctioning the distal colon and also dealing with the technical points of the various operations upon the defunctioned bowel. In a personal communication he states that since he has made use of "this physiological principle" in operations upon the secluded, rested and cleansed intestine his immediate and late results have exceeded all expectations. His operative death-rate was immediately reduced from 30 per cent to 10 per cent, and peritonitis—that most dreaded complication following resection and primary suture of the large bowel—was virtually eliminated. He kindly sent me a reprint of his excellent paper which appeared in that progressive journal *Surgery*, and across the title page were scribbled these words: "The genesis of 'defunctioned': Distal colonic function—the manure pit, the violent explosive movements, the muscular sphincteric barrel—is the cause of the surgical difficulties. Deprive the colon of function, defunction it and the difficulties disappear. Those for 'defunction' to drive this one big point home."

His methods of operating upon the defunctioned distal colon have been widely adopted in Great Britain with most encouraging successes, while in America his operation has been enthusiastically sponsored by many surgeons including such authorities as DeBakey and Ochsner (*Surg.*, 5:947, 1939; and *J. Am. M. Ass.*, 113:567, 1939). The American is always quick to improve upon the coined word, thus it was not long before "defunctioning" became "defunctionalizing."

Definition of Defunctioned Distal Colon. By this is implied a distal colon which has been completely disconnected so that it cannot be soiled with feces; one from which the fecal contents can be washed out daily with weak antiseptic solutions; and one which has been allowed to remain free from function until such a time as the bacterial content has been considerably reduced—until, in fact, it has been "debacterialized."

The advantages of this plan are apparent, namely: (1) operation can be performed under the most favourable conditions, *i.e.*, in the absence of fecal matter, with colonic walls that are functionless, collapsed and retracted, upon a bowel which has lost all edema and

which has an unimpaired blood supply, and finally upon one in which the bacterial content is reduced to a minimum; (2) the divided ends of the bowel can be joined together with sutures and allowed to heal under conditions which come close to approximating the ideal.

The Method of Operating upon the Defunctioned Distal Colon. This involves the following:

1. Exploratory laparotomy to determine the operability of the lesion.
2. The construction of a disconnecting anus—the defunctioning colostomy.
3. The preparation of the excluded distal colon.
4. A decision as to the type of operation to be performed upon the defunctioned distal colon.

THE EXPLORATION OF THE ABDOMEN. An incision $2\frac{1}{2}$ to 3 inches long is made over the middle third of the right or left rectus muscle in the epigastrium, and, after splitting the muscle fibres in a vertical direction, the parietal peritoneum is divided in a line with the skin incision. If the growth is situated in the descending colon, the incision is made to the right of the epigastrium; but if the lesion involves the sigmoid or rectosigmoid, the left side is sometimes chosen. The incision is purposely made small because through it the disconnecting anus is to be fashioned, and if by any chance it becomes infected it will be easier to treat than a large one. Again, a gloved hand well lubricated with warm sterile paraffin will readily slip through this incision and will inflict the minimum of trauma upon the abdominal viscera during the exploration which has to be conducted. The hand should be passed over the surface of the liver to determine whether or not it is studded with implants; it should examine the growth and test its mobility; and it should search the mesenteries, the great omentum and the pelvic shelf for any evidences of spread of malignancy. If the growth is deemed resectable and there are no contra-indications to radical removal of the left colon, the next step consists in the making of a double-barrelled colostomy, either at the proximal third or at the distal third of the transverse colon. For the purpose of the present discussion we will assume that the proximal third of the transverse colon is chosen for the making of the disconnecting anus.

THE CONSTRUCTION OF THE DISCONNECTING ANUS. The disconnecting anus should be fashioned in such a manner as to conform with the following requirements:

1. It should completely disconnect the proximal colon from the distal colon.
2. It should be easy to manage.
3. It should be capable of closure with safety and without difficulty when it is no longer required.
4. It should be placed well away from the site of the second operation (at which the lesion is excised).

The essential step in the operation is to ensure that the distal colon is completely disconnected from the proximal colon, this being achieved by transecting the colon and by inserting the two ends of the bowel into separate openings in the abdominal wall. The ordinary loop colostomy does not effect this disconnection in a satisfactory manner, as when the spur retracts—and all colonic spurs do so in time—some faecal matter and bacteria-laden mucus find their way into the distal opening and re-contaminate the lower segment of bowel. Again, should a subsequent taking down of the colostomy be desired, the surgeon will be faced with a formidable intraperitoneal operation which is not devoid of risk. It is for these reasons that loop colostomy, however skilfully performed, is not employed for the purpose of deflecting the oncoming faecal current nor for preparing the descending colon and sigmoid flexure for radical excision and end-to-end junction.

Loop colostomy is an indispensable procedure in the treatment of inoperable growths of the distal gut, and it also plays an important part in the management of certain lesions of the rectum; but it has no place among those methods which effectively safeguard the distal colon from contamination by intestinal contents.

In the Devine colostomy no faecal matter can find its way from one stoma to the other—the defunctioning is absolute. The proximal stoma should be made in such a way that it can be managed easily; in other words, so that soiling of the abdominal wall may be reduced to a minimum. This is brought about by making a small fistula-like anus at the proximal end of the divided bowel so that the opening can be readily occluded with a spigoted rubber tube for several hours during the day.

When the disconnecting anus is no longer required, intestinal continuity is restored by cutting through the long partition between the sutured limbs of bowel with an enterotome; later, each small rosette of mucous membrane on the skin is dissected out and invaginated into the lumen of the gut.

By making a disconnection in the upper right or left part of the epigastrium of either the proximal or distal segment of the transverse colon, the faecal fistula is placed as far afield as possible from the main area of the second operation.

The disconnecting anus is constructed in the following manner: If the transverse colon is long, it is pulled through the wound; the great omentum is detached from the bowel, pushed back into the abdominal cavity and made to lie on the anterior surface of the stomach, and a rubber tube or a piece of gauze is passed through the mesocolon at the apex of the loop. The loop is next drawn upward and outward and its proximal and distal limbs are approximated with a continuous suture of catgut so as to make a spur of four to six inches long. The adjacent portions of gut near the apex of the loop are not stitched together (fig. 262). If the transverse colon is short, the long spur is made by joining the proximal third of the transverse colon to the mobilised ascending colon and hepatic flexure. The apex of the loop would here be at the hepatic flexure.

If the colostomy is made at the left side, the splenic flexure is loosened from its moorings and the distal third of the transverse colon is fastened to the descending colon, the splenic flexure being at the apex of the loop.

Two small incisions, about 1 inch long and parallel to one another, are made through the skin and subcutaneous tissues, 1 inch on each side of the original abdominal wound. Likewise, two incisions are made in the parietal peritoneum, again about 1 inch long, parallel to one another and at each side of the incised peritoneum. Through these two openings on each side Kocher forceps are introduced into the abdominal cavity and are applied to the apex of the loop in the manner depicted in figure 262 (2).

At the apex of the loop the small triangular portion of bowel between the clamps is excised with a diathermy knife, care being taken not to contaminate the operative field. The subjacent mesocolon is incised down to the point where the sutured limbs of colon

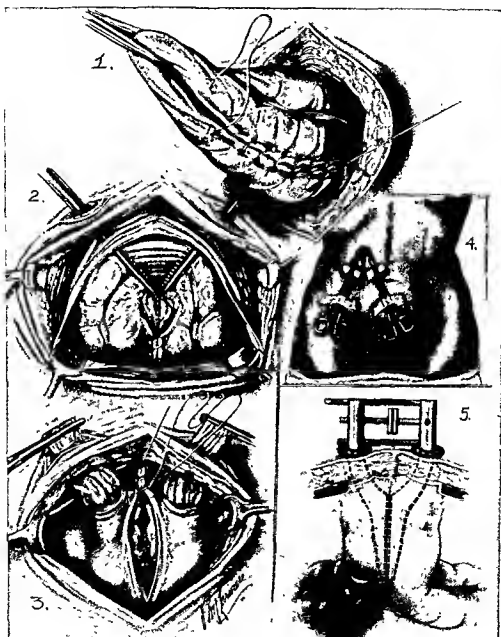


FIG. 262.—THE DEFUNCTIONING COLOSTOMY—DEVINE'S METHOD.

part company, and the proximal and distal stumps are drawn through their respective openings on to the surface of the abdominal wall.

The margins of the parietal peritoneum are now closed with a continuous catgut stitch, but the needle picks up a good bite of mesocolon at the point where the two limbs of gut diverge. This suture not only securely suspends the new apex of the double-barrelled tube to the strong parietal peritoneum and anchors it hard up against the under-surface of the wound, but it also prevents any guileless small intestine from slipping through a dangerous potential aperture (fig. 262 [3]). It will be noted that no sutures are passed where the two limbs of colon slip through the small hole in the peritoneum, nor are any sutures used to fix the stumps of gut to the margins of the small skin incisions. If the holes in the parietal peritoneum and in the skin are made too capacious, they should be reduced by means of interrupted sutures to such a size that they will embrace the issuing limbs of bowel evenly and gently. The retracted margins of the rectus muscle now fall together, and after they have been approximated loosely above and below the two tubes of gut with a few interrupted sutures, the edges of the main skin incision are drawn together with a series of interrupted deknatel or fine silk sutures.

Figure 262 (4) shows the disposal of the two Kocher clamps on the surface of the abdomen at the end of the operation. In order to afford some relief from gaseous distension, one or two small punctures are made with the cautery point in the projecting stump of proximal bowel immediately beneath the blades of the clamp. Through these small perforations the pent-up gases of the alimentary canal will hiss at intermittent periods and thus bring about freedom from any troublesome gas pains.

After forty-eight hours the proximal clamp is removed, but the distal one, which acts as the main support of the exteriorised intestine, is kept in position until it cuts its way through the bowel wall, usually about a week later. By this time the two tubes of large bowel will be everywhere adherent to the deeper structures of the wound, further retraction toward the abdominal cavity is not to be feared, and the two small pointing colostomy openings with their everted rims of mucosa will be seen nicely separated by 2 inches of skin, down the centre of which runs the vertical red line of the healed exploratory incision.

This technique therefore provides an anus which satisfies the four requirements previously outlined: (1) complete disconnection; (2) a small opening which is easily occluded but through which the semi-liquid contents of the proximal colon can be discharged; (3) a long spur, the cutting through of which permits of early restitution of function, and (4) a faecal fistula well away from the area of future operation.

For the management of the disconnecting anus. Devine, in his book, gives the following instructions:

The best way... to control this artificial anus is to insert into it an occluded rubber tube which has a caliber large enough to fit firmly into the opening and to which a large flange of rubber is fixed... The tube is fitted with a cork. The patient can once or twice in the twenty-four hours, either attach a wash-out apparatus to this tube, and wash out the cæcum and ascending colon, or can remove the corked tube, lean over a basin, completely empty the contents of the cæcum and ascending colon, clean himself, and reinsert the corked tube. The patient will then, if the anus be correctly made, remain clean for twenty-four hours.⁵

The Method of Preparing the Excluded Distal Colon for Future Operation. The contents of the distal colon should be washed out once or twice a day for a period of two to four weeks. The irrigations are given through the left colonic stoma as well as per rectum. If none of the fluid injected by way of the rectum can be induced to pass through the abdominal fistula, the segment of bowel above the obstructing agent should be flushed out with antiseptic solution introduced under moderate pressure at least twice a day for about three weeks. Lavage with weak antiseptic solutions such as albargin, rivanol, acriflavine or mercurochrome, greatly helps to diminish the bacterial content of the bowel, while instillations of crude cod-liver oil, which with its high content of vitamin A is by far the best lubricant, are given as a routine measure.

Closure of the Disconnecting Anus. The new DeBakey-Ochsner clamp, a detailed description of which was given in *Surgery*, has rendered this a simple and safe procedure.

The blades of the DeBakey-Ochsner clamp are well lubricated before use, introduced separately and then connected up as illustrated in figure 262 (5). The upper crossbar is fitted first into its correspond-

⁵ Devine, *The Surgery of the Alimentary Tract*, 1910.

ing opening in the other arm of the clamp, along which it then slides until the lower crossbar meets it at the corresponding opening.

This arm of the clamp then slides along both crossbars of the other arm of the clamp until the middle screw bar meets its corresponding opening and by turning the wheel the two arms of the clamp are drawn towards each other. Also as the screw wheel is turned, the crushing blades approximate each other until they gradually cut through the spur. The lower crossbar is so calibrated that it is possible to determine at a glance the exact distance between the two crushing blades beneath the skin surface. The instrument is constructed of duraluminium to give lightness in weight. As the clamp consists of only the working parts, assembly and dis-assembly are considerably facilitated. The two crossbars assure stability, smoothness of operation, and an evenly distributed crushing surface. The crushing force is gradually and easily applied by the wheel screw. It can also be readily determined and constantly controlled by the calibrations on the lower crossbar. Because of its lightness in weight and the fact that the handles project only three or four cms. above the skin surface, it is extremely convenient, simply requiring ordinary dressing. Thus it causes no inconvenience or discomfort and the patient can be walking about while it is applied.*

This efficient and indispensable instrument has already displaced the somewhat clumsy Devine enterotome with its long projecting handle and massive crossbar.

The moment the long spur has been cut through, the bulk of the fecal matter passes per rectum, but some intestinal contents and gas will bubble through the small fistulous openings. If the abdominal fistulae continue to discharge for any length of time, it is an easy matter to dissect them free from the skin and subcutaneous tissues, and to close them with catgut stitches.

The Type of Operation to be Performed Upon the Defunctioned Distal Colon. Four operations will be described:

1. Partial sigmoidectomy with end-to-end anastomosis.
2. Resection of the rectosigmoidal region together with adjacent portions of bowel, followed by end-to-end anastomosis.
3. Resection of the rectosigmoidal region together with adjacent portions of bowel, followed by "telescopic" anastomosis.
4. Colotomy for the removal of polypi.

PARTIAL SIGMOIDECTOMY WITH END-TO-END ANASTOMOSIS. At the second operation the abdomen is explored through a left low para-

* DeBakey and Ochsner, *Surg.*, 5 917, 1939. Courtesy of C. V. Mosby Co.

median or through an oblique muscle-cutting incision, and the mobilisation of the descending colon and sigmoid loop, the wide excision of the mesosigmoid, and the closure of the gap in the mesentery proceed on the same lines as in the Mikulicz operation (see page 1204). The long loop of bowel, which has been loosened together with its attached mesentery, is drawn through the wound, which is well protected with waterproof sheets and gauze squares. At either end of the portion of bowel to be removed, a circular incision is made through the serosa and muscularis, but not through the submucosa and mucosa. Owing to the retraction of the longitudinal bands, the sacculations in the gut immediately disappear and the bowel takes on a more tubular form and is therefore easier to suture. The seromuscular layer on each side of the incision in the gut is stripped upward and downward to form a cuff, leaving a tube of mucosa to which is applied a pair of Shoemaker forceps or a pair of artery forceps with long thin blades (fig. 263 [6]). These clamps are applied to the proximal and distal cuffs of mucosa so that when the narrow strips of mucous membrane between the two pairs of clamps are burned through with a cautery or with a diathermy needle, the diseased segment of bowel can be removed without any spillage of intestinal contents.

The blades of the clamps on the proximal and distal ends of the divided intestine are now laid side by side parallel to one another, and an anterior series of seromuscular Lembert—or preferably Halsted—sutures are inserted in the manner depicted in figure 263 (7). These sutures pick up only the seromuscular layer of the bowel and the needle does not penetrate the lumen of the gut. As these sutures are gently tied, they approximate and invert the anterior margins of the divided ends of the gut. The handles of the clamps are next rotated inward toward the middle line, thus displaying the posterior aspect of the blades of the clamps and the ends of the divided colon. A posterior series of seromuscular Lembert or Halsted sutures is inserted and tied in the same way as the anterior ones, after which the clamps are carefully loosened and removed (fig. 263 [8]).

A stitch or two at any weak point, and especially at the corners, completes the end-to-end junction. The abdominal wound is closed in the usual manner, and a drainage tube may or may not be inserted down to the anastomotic junction.

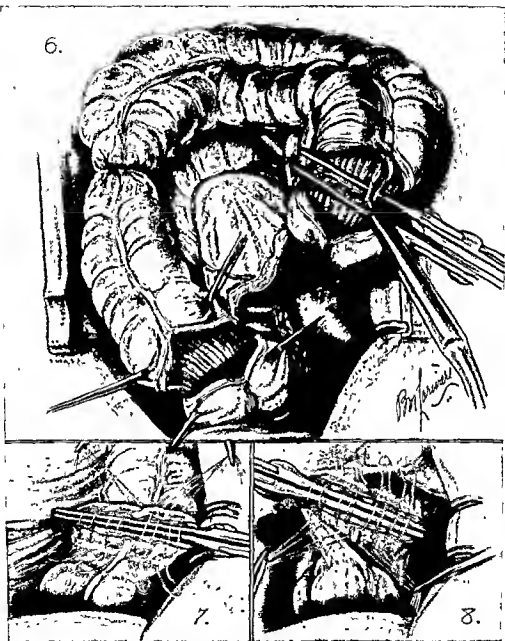


FIG. 263.—RESECTION OF THE SIGMOID COLON FOR A MALIGNANT LESION WITH
END-TO-END ANASTOMOSIS WITH THE AID OF SHOELMAKER FORCEPS.

About two or three weeks after this operation, the spur of the de-functioning colostomy is destroyed with an enterotome, and intestinal continuity is once again re-established.

RESECTION OF THE RECTOSIGMOID WITH END-TO-END ANASTOMOSIS. In this operation the whole of the sigmoid loop and approximately the upper quarter of the rectum are removed together with the growth and adjacent mesentery, and the cut ends of the sigmoid colon and rectum are sutured together with a single layer of stitches. It is in malignant tumours of the lower third of the sigmoid that Devine's method of operating upon the defunctioned colon is so valuable. It permits of an extensive resection and of an axial anastomosis with little risk of leakage or peritonitis and with every prospect of success.

It may be said that this resection is not radical enough and takes no account of the lateral and downward spread of the malignant growth. However, in cases in which a conservative resection is indicated for growths of the lower third of the sigmoid, it has no rival.

Among the alternative procedures to this method may be mentioned Miles's abdominoperineal operation (see page 1291). Hartmann's anterior resection with permanent colostomy (see page 1279). Rankin's obstructive resection (*Ann. Surg.*, 103:235, 1936) and the extraperitoneal procedure of Mikulicz. The relative merits and indications for Miles's abdominoperineal operation and for Hartmann's abdominal resection of the rectum with terminal colostomy are discussed in Chapter 9 of this part.

Four objections are commonly raised against the Rankin and the Mikulicz types of procedures when these are applied to growths located in the lower third of the sigmoid colon:

1. The amount of mesosigmoid excised is inadequate.
2. Not enough bowel on the rectal side of the growth is removed.
3. It is difficult and in some cases even impossible to mobilise the rectum to such an extent that it can be freely drawn through the abdominal incision.
4. When it is possible to deliver the liberated rectum through the abdominal wound and to secure it in the blades of a Rankin or other clamp, it may be pulled upon over a long period with such force that its blood supply may be cut off, or again when the supporting clamp is released it may retract into the depths of the wound or even slip back and lie free in the abdominal cavity.

The second stage of the Devine operation is performed about two or three weeks after the disconnecting anus has been made, a median sub-umbilical or a low left paramedian incision being the approach usually selected. The peritoneal reflection of the pelvic mesocolon is incised, starting at the inner side above the level of the origin of the superior hæmorrhoidal vessels, *i.e.*, at a point just below the bifurcation of the aorta, and then laterally commencing some 5 inches or so above the level of the superior iliac crest. The peritoneal incisions are then extended downward across the pelvic floor to meet over the base of the bladder in the male or over the posterior aspect of the cervix in the female. During this dissection the ureters will be seen and should be gently pushed aside. The superior hæmorrhoidal vessels are next tied with two strong silk ligatures as close to their origin as possible, after which the stout vascular pedicle is divided with scissors. The ligatures must in all cases be placed distal to the origin of the sigmoidal arteries, as if these are inadvertently tied off, impairment of the circulation in the proximal segment of bowel is likely to occur.

The whole of the pelvic colon and the upper half of the rectum are now mobilised by digital elevation of the gland-bearing tissues from the hollow of the sacrum. Clamps are applied to the upper part of the rectum and to the first part of the sigmoid or distal end of the descending colon, and the diseased loop of bowel with its attached mesentery is removed in one piece, as in figure 264 (1).

After making sure that the cut ends of the colon and rectum have an ample blood supply, the end of the colon is brought down to the rectal stump, placed in correct apposition to it and secured in this position by two long stay sutures which not only fix the segments *together but act as efficient retractors throughout the suturing*. The posterior and lateral margins of the rectum and colon are approximated with a series of interrupted sutures of No. 0 twenty-day chromic catgut. The sutures are inserted from the lumen of the bowel, as illustrated in figure 264 (2), this being the simplest method of inserting them.

A few cross stitches draw together the edges of the anterior wall of the rectum and colon and are tied fairly lightly. Only one row of sutures is used in making this axial anastomosis.

The next step is to draw together and suture the peritoneal leaves

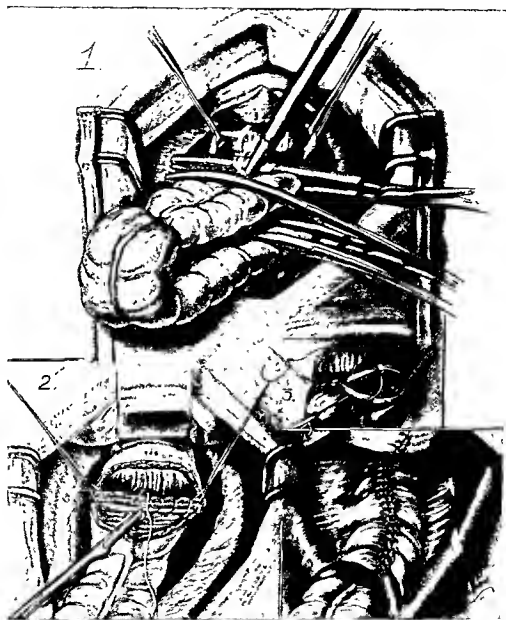


FIG. 264.—RESECTION OF A GROWTH OF THE LOWER THIRD OF THE SIGMOID COLON TOGETHER WITH A PORTION OF THE RECTUM AND PELVIC COLON, FOLLOWED BY END-TO-END ANASTOMOSIS BY THE METHOD OF DEVINE.

to the sides of the proximal segment of the colon, forming a reconstructed and a more shallow pelvis than was present before the resection (fig. 264 [4]).

The anastomotic line will almost invariably be retroperitoneal after this reconstruction has been effected. The external sphincter is fully stretched with the fingers, a tube is inserted into the rectum, a Penrose drain is passed through the newly-constructed pelvic floor into the hollow of the sacrum, and the abdominal wound itself is then drained with a piece of corrugated rubber. About two or three weeks later the spur of the disconnecting anus is crushed and the faeces pass on into the distal colon and so per rectum.

During the last seven years Dixon of the Mayo Clinic (*Am. J. Surg.*, 46:12, 1939) has performed over 100 operations of this type with a low mortality and with results which he describes as encouraging. He states that the anastomosis can often be felt upon digital rectal examination, and that the lumen of the bowel at the site of the anastomotic junction is somewhat smaller than normal; but he has observed no case in which this narrowing was of such a degree that closure of the colostomy seemed inadvisable.

RESECTION OF THE RECTOSIGMOID WITH TELESCOPIC ANASTOMOSIS. In a few cases of resection of the rectosigmoid for growth or for diverticulitis, a sutured anastomosis between the upper end of the sigmoid and the cut margin of the rectum cannot be made because of certain mechanical difficulties. This occurs in obese patients, in males who have a narrow pelvis, and where there is a small or short rectal stump. In circumstances such as these, the cut end of the rectum should be closed and inverted with catgut sutures, the leaves of the pelvic peritoneum should be approximated, thus reconstructing the pelvic floor, and the cut end of the proximal colon should be implanted into the abdominal wall as a non-functioning stoma. Some months later, if it is thought advisable to re-establish intestinal continuity, the sigmoid is freed from the abdominal incision, the splenic flexure and descending colon are generously mobilised, a long, wide-bore, slotted rubber tube is introduced into the end of the sigmoid and stitched into position, and this tube, together with a short segment of sigmoid, is drawn through an opening which is made in the pelvic peritoneum and in the dome of the rectal pouch.

The sigmoid is telescoped into the rectal pouch and the contiguous

margins of the serous-lined bowel and the parietal peritoneum are united with a few sutures, thus helping to anchor the invaginated gut in position. The rubber tube which projects beyond the margin of the anus is fixed into position by gauze packing and by a large safety-pin. The external sphincter muscle is then divided. This tube, which works loose at the end of a week or so, keeps the anastomosis in place and also drains off any blood or mucus which finds its way into the rectal pouch. Intestinal continuity is re-established by crushing the spur of the defunctioning colostomy as soon as the telescoped bowel has had sufficient time to become adequately fused into position.

In theory this is a sound and safe operation, but in practice it is sometimes difficult to execute in a satisfactory manner.

At the final operation, when the telescoping is being performed, it is not uncommon to find in males that the bladder has prolapsed or has been dragged backward toward the sacrum and occupies the whole of the reconstructed pelvic floor, or in the female that the uterus and appendages have become adherent to the dome of the rectal cul de sac. The dangerous process of freeing these structures deep down in the hollow of the pelvis is a major surgical undertaking, and often when they are liberated by cautious dissection from their oozing bed, the space which is left for the bulky tube of colon to pass through to its new position is niggardly, cramped and encompassed by fibrotic bands and adhesions.

COLOTOMY OR SIGMOIDOTOMY FOR REMOVAL OF POLYPI. In cases where a number of polypi are clustered together in the descending colon or are located in the sigmoid loop, or where perhaps one large suspicious-looking adenoma can be seen in skiagrams, after defunctioning the colon the bowel can be freely incised and the neoplasms removed without any fear that the suture line will subsequently leak and cause a spreading peritonitis.

III. Intraperitoneal Resection and Anastomosis. Primary resection and primary anastomosis, or anastomosis (ileo-transverse colostomy) followed a fortnight or so later by hemi-colectomy, for tumours of the proximal colon, are time-honoured, well-standardised, radical operations which are widely practised by surgeons in many clinics throughout the world with good results. These intraperitoneal operations for malignancies of the right half of the colon have remained

unchallenged and aloof from any serious criticisms until recent years when the resurrected and improved extraperitoneal procedure of Mikulicz came to be applied to the right segment of the large bowel with a success comparable to that which attended this method when performed upon the left side.

Primary resection with primary anastomosis supplemented by cæcostomy for tumours of the distal half of the colon is not being practised so frequently today as was the case ten or fifteen years ago. The mortality of this operation when performed for carcinomatous lesions of the distal colon was high, approximately 30 per cent, and most of the deaths were due to peritonitis. Nor did the method of anastomosis in any way influence the death-rate, whether it was end-to-end or side-to-side, or whether three rows, four rows, or but a single row of sutures was employed. It is not surprising therefore that during the last decade the modified Mikulicz resection and the safe methods of Devine should have come rapidly into favour and supplanted in large measure the intraperitoneal operation, both in this country and in America.

Right Hemi-Colectomy. The resection of the last 6 or 9 inches of the ileum, the cæcum, the ascending colon and the proximal part of the transverse colon for malignant lesions involving the segment of the bowel may be carried out in one stage or, as I prefer, in two stages.

Through a right paramedian para-umbilical incision the tumour is examined, and if it is found to be removable and there are no contra-indications to excision, the proximal colon, the cæcum and the last 12 inches of the ileum are pulled through the wound. The margins of the wound and the rest of the abdominal cavity are packed off with large moist squares in the usual manner. A point on the ileum some 6 to 9 inches from the ileocæcal junction is chosen for the transection, and the meso-ileum immediately opposite this point is obliquely divided toward the root of the mesentery for a distance of about 3 inches, the upper two or three arching blood vessels being underrun with an aneurysm needle and ligatured with silk. The ileum is then crushed with a powerful enterotome, transfixed and ligatured in two places, divided with a diathermy knife between the ligatures and the distal end of the bowel invaginated with two purse-string sutures of silk in the manner shown in figures 265 and 266.



FIG. 265.—RIGHT HEMI-COLECTOMY—FIRST STAGE.
Transection of the ileum at the seat of election.

The proximal end of the ileum is trimmed obliquely to ensure that the cut margin has a virile blood supply, and when this is established it is embraced in an enterostomy clamp and lifted upward toward the under-surface of the transverse colon toward the right margin of the middle third of this portion of the bowel. An end-to-side anastomosis—ileo-transverse colostomy—is next made with three rows of sutures (fig. 266 [5]). The excluded stump of ileum is doubled back on itself and kept in this position with a few interrupted sutures of fine catgut. The vertical cut margin of the mesentery is sutured to the mesocolon with a series of interrupted sutures in order to close what would be a dangerous aperture between the mesocolon and the limb of bowel which runs to the anastomotic junction. The abdominal incision is then closed without drainage.

The second stage is carried out two or three weeks later through a large right oblique muscle-cutting incision which extends from the tip of the tenth rib and curves downward toward the pubis. At the lower end of the incision the anterior sheath of the rectus muscle is divided transversely and the fleshy belly is freed and firmly retracted inward toward the middle line.

The first step in the operation consists in stripping the great omentum away from the middle third and from the right lateral aspect of the transverse colon, of lifting the liberated omentum upward to display the lesser sac and more particularly the upper surface of the mesocolon, of dividing it vertically toward the greater curvature of the stomach up to the arching vascular epiploic vessels, and of ligating it, piece by piece, below these vessels until it is free and the second portion of the duodenum is well exposed (figs. 267, 268 and 269). (The entire procedure may be followed in all stages in the *illustrations*.)

As soon as this portion of the omentum is cut adrift from the right side of the greater curvature, the strong fibres of the duodeno-colic ligament are clamped and snipped through with scissors, thus further liberating the anchored transverse colon (fig. 269 [9]). The whole of the right colon is now speedily mobilised by dividing the parietal peritoneum at the lateral aspects of the hepatic flexure, descending colon and cæcum, and by sweeping the bowel and its attached mesenteric leaf boldly inward toward the middle line. The retroperitoneal duodenum, the lower half of the right kidney, the ureter, and the



FIG. 266.—RIGHT HEMI-COLECTOMY—FIRST STAGE.

Closure and invagination of the distal end of the ileum, preparing the proximal end of the ileum for anastomosis with the transverse colon and the performance of end-to-side ileo-transverse colostomy with the aid of clamps. Note how the distal ileal loop is doubled back on itself.

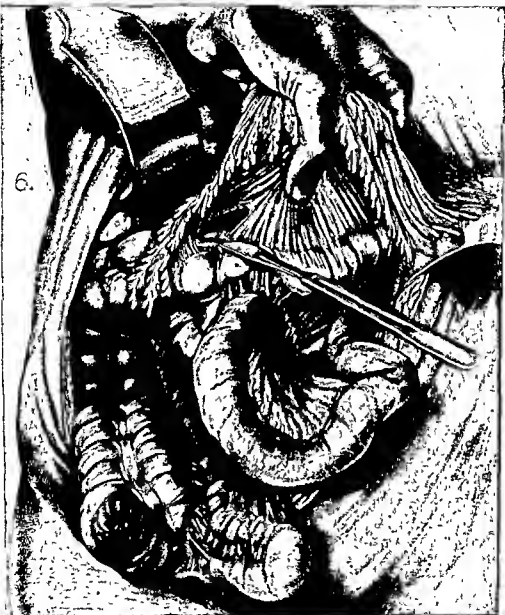


FIG. 267.—RIGHT HEMI COLECTOMY—SECOND STAGE.
The great omentum is being freed from the transverse colon.

ovarian or spermatic vessels, will be clearly seen during this dissection and these important structures must be carefully protected from injury (figs. 270 and 271).

The freed segment of gut is held up to the light to define even more clearly than before its vascular supply, and the ileo-colic artery



FIG. 268.—RIGHT HEMI-COLECTOMY—SECOND STAGE.

The great omentum has been freed from the middle portion of the transverse colon and is being divided with scissors up to the vascular epiploic arch.

and the right colic artery are isolated and underrun with an aneurysm needle, ligatured with strong silk in two places and then divided (fig. 272). The right margin of the mesocolon is cut through, the arching anastomotic branch of the right colic artery on its way to its anastomosis with the middle colic artery is tied, and a portion of the transverse colon about 2 to 2½ inches proximal to the anasto-

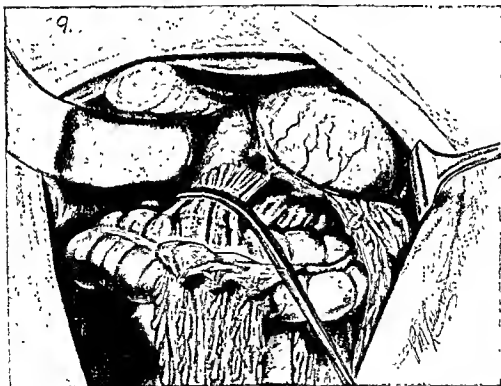


FIG. 269.—RIGHT HEMI-COLECTOMY—SECOND STAGE.

The great omentum is being ligatured off and divided from the right margin of the greater curvature of the stomach, care being taken to preserve the vascular epiploic arch.

The bottom figure shows the strong duodeno-colic ligament clamped and ready for division.



FIG. 270.—RIGHT HEMI COLECTOMY—SECOND STAGE.

The right colon is being mobilised and some stout bands of fascia near the hepatic flexure are being snipped through with scissors.



FIG. 271.—RIGHT HEMI-COLECTOMY—SECOND STAGE.

The mobilisation of the right colon is being proceeded with. Note the position of the retro-peritoneal duodenum, the lower pole of the kidney, the ureter, and the ovarian blood vessels.



FIG. 272.—RIGHT HEMI-COLECTOMY—SECOND STAGE.

The ileo-colic artery has been ligatured in two places near its origin and is about to be divided. The arching branch of the middle colic artery on its way to its junction with the ascending branch of the right colic artery is being underrun with an aneurysm needle and tied off.

13.

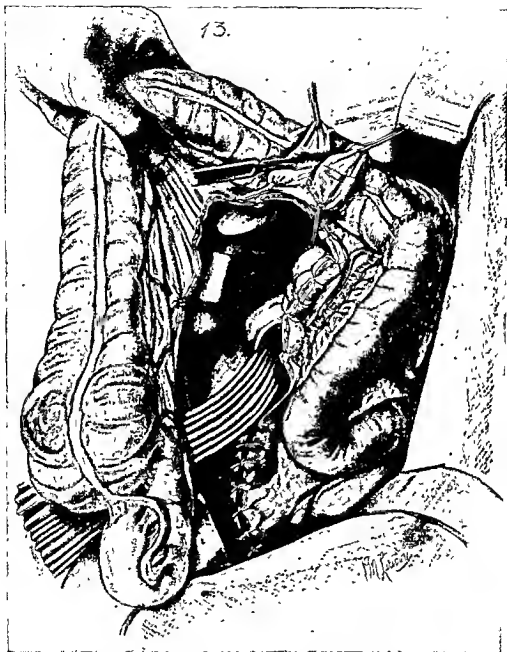


FIG. 273.—RIGHT HEMI COLECTOMY—SECOND STAGE.

The transverse colon is being prepared for transection about two inches or so proximal to the ileo-colonic stoma.

motoc junction is freed from all fatty tissues and prepared for transection.

The circular incision is made in the bowel wall through the sero-muscular coat down to the mucosa (fig. 273). A cuff of mucous membrane is fashioned and this is ligatured, clamped and burned through with a cautery, after which the small stump of mucous membrane and the adjacent bowel are liberally invaginated with two purse-string sutures into the capacious colon on the proximal side of the anastomotic stoma. This is well illustrated by means of figure 274.

The operation is completed by suturing a portion of the omentum over the colonic stump and by covering over the area on the posterior abdominal wall which has been deprived of its peritoneum. The parietal peritoneum here will need mobilising before it can be stitched to the side of the mesocolon. Drainage is provided for twenty-four to forty-eight hours by means of a long piece of corrugated rubber sheeting.

When the operation is done in one stage, and this is the method preferred by a number of surgeons, a large right paramedian incision is employed. An end-to-side or a side-to-side isoperistaltic ileo-transverse colostomy is first performed in the manner just described, and then the right colon is mobilised and the resection is carried out. Some prefer to start the operation with the mobilisation of the cæcum and ascending colon, and after ligaturing the ileocolic and the right colic arteries, to divide the mesenteric leaf, to transect the terminal ileum and proximal transverse colon, to close the ends of the bowel, and then to complete the operation by performing a side-to-side isoperistaltic anastomosis using two continuous layers of catgut or silk sutures.

FINAL OBSERVATIONS WITH REGARD TO CHOICE OF OPERATION

For operable growths of the proximal colon I would advise a preliminary ileo-transverse colostomy followed later by hemi-colectomy, the second choice being a one-stage primary anastomosis with primary resection or a Mikulicz resection after the plan of Lahey.

For growths of the transverse colon the safest procedure is an extra-

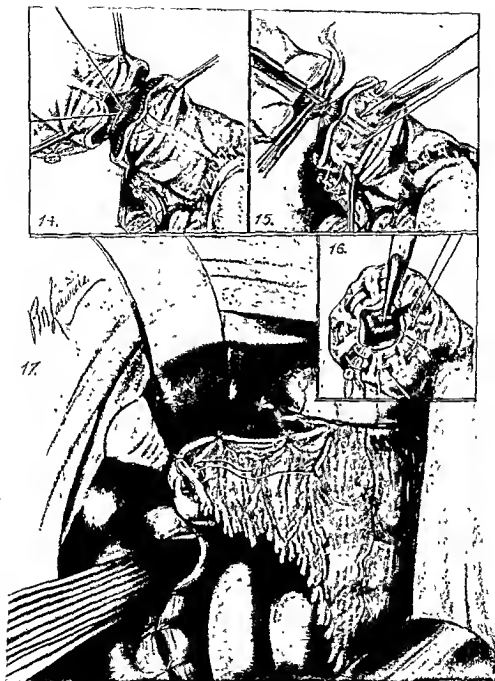


FIG. 274.—RIGHT HEMI-COLECTOMY—SECOND STAGE.

This illustration depicts the method of dividing the transverse colon and securely closing and invaginating the stump of bowel proximal to the ileo colostomy.

peritoneal operation adapted on the lines laid down by Mikulicz and Rankin.

For growths of the descending colon and the proximal two-thirds of the sigmoid loop, the surgeon has a choice of two safe and valuable operations: namely, that of Mikulicz and that of Devine.

For growths of the lower third of the sigmoid colon, should a conservative resection be indicated, the best procedure is that advised by Devine.

THE TREATMENT OF THE INOPERABLE CASES

For irremovable growths of the proximal colon, as soon as any obstructive symptoms have been relieved, a side-to-side ileo-transverse colostomy should be performed in order to short-circuit the obstructing malignant mass. Following this operation one of my patients lived for two years, but the average life-expectancy is only about nine to sixteen months.

For inoperable growths of the descending colon and sigmoid flexure, a simple loop colostomy made at the transverse colon through a small right or left transverse muscle-cutting epigastric incision is the procedure advocated.

CHAPTER 9

CANCER OF THE RECTUM AND OF THE RECTOSIGMOIDAL JUNCTION

After the stomach, the rectum and rectosigmoid are the most frequent sites in the gastro-intestinal tract for malignant disease. Cancer of the rectum comprises about 5 per cent of all malignant tumours, and between 50 per cent and 60 per cent of the carcinomata of the large intestine occur either in the rectum or in the rectosigmoidal region. Approximately 70 per cent of rectal cancers involve the upper third of the rectum and the last few inches of the colon; 25 per cent are found in the capacious ampulla; while only 5 per cent are situated in the distal inch or so of the rectum or in the anal canal.

It is very doubtful whether such lesions as hæmorrhoids, fistula-in-ano or anal fissure, etc., have any direct bearing on the ætiology of rectal growths, although according to Rosser (*Am. J. Surg.*, 11:328, 1931) on rare occasions the internal openings of fistulæ have been known to undergo malignant change.

Benign tumours of epithelial origin, such as adenomata or papillomata, when arising in the rectum, are prone to undergo cancerous transformation. Lockhart-Mummery and Dukes (*Surg., Gynec. & Obst.*, 46:59, 1928) have shown that in a number of cases cancer of the rectum passes through three well-defined stages:

1. The development of an epithelial hyperplasia, visible macroscopically and involving a wide area of bowel.
2. The appearance of a crop of polypi scattered over the region affected by the initial hyperplasia.
3. The development of cancer either in one of these adenomata or in the neighbouring epithelium.

Multiple malignant tumours occurring simultaneously in the rectum and in the rectum and distal colon are by no means infrequent, and a number of cases have been described by Norbury (*Proc. Roy. Soc. Med.*, 24:198, 1930). In 100 consecutive excisions Gabriel found eight instances of two growths, and he maintains that this constitutes

a very good argument for performing an extensive operation which will remove a long length of rectum and pelvic colon. He also points out that not only may double growths of the rectum occur spontaneously, but they may also arise at intervals. Thus in several instances a patient subjected to a perineal excision of the rectum has ultimately developed another cancer in the stump of pelvic colon between the colostomy and the reconstructed pelvic floor.

The disease is commoner in males than in females in the ratio of 3 to 2, and occurs most frequently between the ages of 50 and 60, although some 60 per cent of patients submitted to operation are between the ages of 70 and 80 and about 4 per cent are aged 30 or under.

PATHOLOGY

As a rule, carcinomata of the rectum grow very slowly, are of only moderate malignancy like those of the colon, and do not extend beyond the gut wall or give rise to metastatic deposits until a comparatively late stage in the disease has been reached. In nearly every instance the microscopical picture is that of adenocarcinoma or malignant adenoma.

In 5 to 10 per cent of cases the growth undergoes mucoid or colloid degeneration.

METHODS OF SPREAD

There are three routes of spread of a cancer of the rectum:

1. By direct extension.
2. By the blood stream.
3. By way of the lymphatic system.

Direct Extension. Direct extension through continuity of tissue takes place in two directions, namely, (*a*) on the mucous surface of the bowel progressively from its entire margin, and (*b*) through the remaining layers of the gut wall.

Ernest Miles, to whom I am indebted for much valuable teaching and advice and to whom I am very grateful for personal demonstrations of his work, has made a life-long study of cancer of the rectum. He writes on this important subject as follows:

The marginal increase is generally greater and more rapid in the transverse direction than in the longitudinal axis of the bowel. It is not uncommon to

find that, whereas nearly the whole of the circumference of the ampulla has been invaded, the extent of the growth longitudinally is less than two inches. The growing edge undermines the more normal mucous membrane extending in the submucous tissue deep to the muscularis mucosæ. Such surface extension is comparatively slow; thus, in the ampulla, for instance, it will take about six months for the growth to travel round a quarter of the circumference in an average case.

Whilst surface extension is slowly progressing, the more important deep infiltration of the muscular coat of the bowel is taking place. This infiltration probably begins at the centre or oldest part of the tumour, but owing to the fact that surface extension takes place unequally, it may happen that the most fixed and indurated portion is eccentric. The fact that the centre of the growth is opposite an important structure, such as the prostate or the base of the bladder, does not imply that penetration of the bowel is occurring at that point, and that actual invasion of the structure has taken place, although the rectum may appear to be adherent to it.

Direct extension through the muscular coat of the bowel appears to be a slow process. When the bowel wall has been penetrated the growth invades the peri rectal fat, through which it extends until it reaches the fascia propria of the rectum.

According to my observations upon this point the fascia propria is not usually invaded until the growth has existed long enough for more than three-quarters of the circumference of the ampulla to have been encompassed, thus indicating that the disease has existed for about eighteen months.

It will be seen, therefore, that the mode of spread through continuity of tissue is a comparatively slow process, and that direct invasion of neighbouring structures does not take place until the growth in the rectum has involved the greater part of the circumference of the bowel.

If extension of cancer through continuity of tissue were the only or even the usual mode of spread from the rectum, the surgical treatment of the disease would be quite simple because, unless the growth has extended beyond the confines of the fascia, a restricted operation, entailing nothing but the removal of the portion of the musculo-membranous tube containing the cancer in its interior, would be all that was necessary to rid the patient completely of his disease. Unfortunately, however, other and more important modes of spread take place simultaneously and with greater rapidity, leading to distant dissemination even when the primary growth is still in an early phase of development.

By the Blood Stream. There is no doubt whatever that cancer cells sometimes penetrate into the interior of small veins, and, becoming detached, are carried in the blood stream. The actual invasion of a venous radical is occasionally seen in microscopical sections of carcinomatous tumours. As the rectal veins belong to the portal system, cancer cells penetrating them are carried straight to the liver....

It is fortunate that dissemination by the veins is very rarely encountered, so that in practice we can disregard the possibility of its occurrence.

By Way of the Lymphatic Vessels. Infinitely more important is the dissemination of cancer cells through the lymphatic channels, and a knowledge of the lymphatic system is essential to the performance of any radical operation on cancer....

It may be regarded as an axiom that whenever a visible metastasis exists, other metastases, which cannot be recognised without the aid of the microscope, also exist along the course of the lymphatics, at points more distant from the seat of the primary growth.

We may consider the extra-mural paths in three divisions, remembering that communications exist between them.

(1) *The Zone of Downward Spread.* The structures comprised in this zone are the perianal skin, the ischio-rectal fat, and the external sphincter muscle. Owing to the free intercommunication between the lymphatics of those structures and the efferents from the rectum, it is easy to understand how the progress of a detached cancer cell may be arrested at any point in that extensive network.... Additional evidence upon this point is forthcoming from clinical records in regard to post-operative recurrent growths.

(2) *The Zone of Lateral Spread.* This area embraces the structures the lymphatics of which enter into relation with the extensive lymphatic network between the levatores ani and the pelvic fascia. These structures are the levator ani muscles, the coccygei, the pelvic peritoneum, the prostate gland, the base of the bladder, the cervix uteri, the base of the left broad ligament and the internal iliac glands.

The levatores ani are sometimes the seat of metastasis.... These muscles are exceedingly prone to invasion by cancer cells, which gain access to the extra-mural lymphatics before the deep infiltration of the primary growth has had time to penetrate the muscular coat of the bowel, and they should, in all cases, be completely removed when a cancerous rectum is excised.

I have observed plaque deposits in the peritoneum of the pelvic floor upon so many occasions that it would not be an exaggeration to say that there is not a portion of it, from the middle line to the brim of the true pelvis, that has not been implicated. This is no doubt due to the fact that the peritoneum in this locality is in close relationship with the extensive lymphatic network situated between the levatores ani and the pelvic fascia. A metastatic deposit in this network, therefore, speedily penetrates the pelvic fascia and extends into the overlying pelvic peritoneum. Accordingly it is essential that the peritoneum of the entire pelvic floor, as far as the brim of the true pelvis on both sides, should be removed in every case of extirpation of the cancerous rectum in which immunity from recurrence is hoped for.

(3) *The Zone of Upward Spread.* The tissues of this zone are the retro rectal (lowermost mesocolic) glands, the pelvic mesocolon in its entirety, the paracolic glands, the glands situated at the bifurcation of the left common iliac artery,

and the median lumbar (aortic) glands. Since the majority of the efferent lymphatics, which form the intra-mural lymphatic system, either pass through or terminate in the structures contained in this zone, it follows that these structures constitute the principal paths by which cancer cells spread from primary growths in the rectum. In fact, this is the most constant and, therefore, the most important of all the routes of spread...

The pelvic mesocolon, throughout its extent, is particularly liable to invasion. So often, indeed, is it found to be the seat of metastatic deposit that the removal of the whole of this structure in every operable case of cancer of the rectum is just as important as is thorough clearance of the axilla in breast cancer.

The part of the pelvic mesocolon which is frequently invaded is its parietal border, between the layers of which the superior hæmorrhoidal and the inferior mesenteric vessels are situated. The efferent lymphatics from the retro-rectal glands accompany these vessels on their way to the glands located at the bifurcation of the left common iliac artery, and constitute the principal route by which cancer cells from the rectum are carried by the lymph stream. At any point along this line metastases may occur, either singly or in chains.¹

Gabriel, in his well-known book, *Rectal Surgery* (2nd ed., 1937), on the other hand, states that lymphatic spread in carcinoma of the rectum usually follows a regular course. The first glands to be invaded by malignant cells are those in the meso-rectum situated just behind the lesion or within one inch or so of its upper growing edge. From this point the higher nodes are involved in sequence, and in a late case the chain of malignant glands is often found along the course of the superior hæmorrhoidal blood vessels. It is only on very rare occasions that lymphatic metastases appear to miss some glands and invade those at a higher level. "Extension to the paracolic glands and downward extension to the peri-rectal tissues are only found in late cases in which extensive extra-rectal spread has taken place, with occlusion of the trunk lymphatics by permeation with growth or by compression in a mass of growth behind the upper rectum."

DIAGNOSIS AND SYMPTOMS

The diagnosis of carcinoma of the rectum can be established:

1. By Clinical Methods. These include: (a) history of the case; (b) digital examination; (c) general and abdominal examination; (d)

¹ Ernest Miles, *Postgraduate Surgery*, Medical Publications, Ltd., London. Vol. 3, p. 1128, 1936.

examination with the proctoscope; (e) examination with the sigmoidoscope; (f) biopsy; and (g) barium enema roentgen-ray examination.

The symptoms will vary according to the position, the type and the duration of the growth. Lesions of the ampulla of the rectum are as a rule insidious in their inception and early progress, while epitheliomata of the anus quickly declare themselves. If we exclude these latter lesions, the earliest symptoms of cancer of the rectum would include: (1) abnormal stools; (2) alteration in the normal bowel function, and (3) unexplained abdominal cramp. Local pain is a late and ominous manifestation except, of course, in connection with malignant lesions of the anal canal itself.

Symptoms of a Growth in the Rectosigmoidal Junction. Growths in this situation of the bowel generally conform to the type encountered in the colon in that they rapidly involve the circumference of the bowel and produce stenosis. Both the proliferative and the annular types occur here and each is attended by a different train of symptoms.

A malignant papillomatous mass in the rectosigmoid region gives rise to excessive mucous secretion and therefore causes diarrhœa, which, although slight at first, tends in time to become more marked. The slimy motions are frequently slightly blood-stained, but when a large fragment of growth becomes detached there is likely to be a sharp hæmorrhage. After a variable interval, the diarrhœa, which has become excessive, ceases and an attack of intestinal obstruction supervenes, either from intussusception of the bulky fleshy mass into the rectum or from impaction of fæces or barium above the strictured area (fig. 275).

The annular sclerosing carcinoma, on the other hand, which encircles the bowel, is in its early stages associated with slight alteration in bowel habits, with increasing constipation, accompanied by mild colicky abdominal pains, borborygmi and flatulence. As the constipation becomes more obdurate, the patient is forced to take more aperients to ensure frequent watery evacuations, since by this time no solid fæces can pass the stenosed area.

After a while the bowels cease to act, meteorism becomes extreme, and intermittent cramp-like pains denote the presence of a blockage. In some cases an attack of acute intestinal obstruction is the first indi-

cation of the sinister presence of a scirrhus ring-cancer of the recto-sigmoid region.

It is common experience to find that cancers of this segment of the bowel are operable because they come under observation at a comparatively early date on account of the urgency of the symptoms produced by the stenosis.

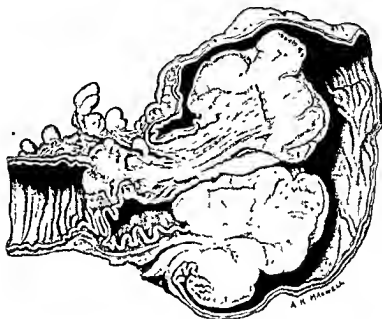


FIG. 275.—INTUSSUSCEPTION OF A BULKY FLESHY RECTO-SIGMOIDAL GROWTH.
(Cecil P. G. Wakeley.)

Symptoms of a Growth in the Anal Canal. Cancer of the anus frequently arises in the anal canal at the junction of the columnar- and squamous-celled lining. The lesion is a squamous-celled carcinoma-epithelioma. It forms a flat infiltrating growth with a raised uneven ulcerating surface and a hardened rolled-out edge. It generally grows downward and invades the skin of the perineum rather than extending upward into the rectum. Metastatic implants develop in the inguinal lymph glands and at a late stage the lymphatic structures along the external iliac arteries become implicated by the upward spread of the disease. Involvement of the external sphincter muscle and of the levatores ani leads to incontinence of feces. Cancers of the anus produce definite early objective symptoms, and their presence is usually de-

tected while they are still amenable to treatment with radium or by excision with a diathermy knife.

The early symptoms are similar to those of anal fissure: there is, for instance, a sharp cutting pain during defæcation, this being followed by a dull ache in the perineum which may persist for many hours. After each action of the bowels there is a sensation of incomplete relief. Pruritus is a troublesome feature. Bleeding is usually slight, but may at time be severe, especially if the surface of the growth becomes lacerated.

It must be emphasised that the first symptom of anal cancer is pain, and as this is often severe it generally leads to early examination and consequent early diagnosis.

Symptoms of Growth in the Ampulla. The ampulla of the rectum is capacious and its mucous membrane is insensitive unless it is stretched. Malignant lesions situated here do not give rise to any symptoms during their early stages of growth unless they bleed or cause some interference with function. In fact, they behave like tumours of the body of the stomach and remain silent for many months. After a time, however, the surface of the growth disintegrates, and when this takes place blood is passed in the motions. Thus the earliest objective sign of the existence of an ampullary growth is the streaking of the stools with blood.

A malignant adenoma, owing to the fact that the exuberant mass bulges into the lumen of the bowel, may attract attention by producing a sensation of fullness in the rectum or an impression after defæcation that the bowel has been incompletely emptied. When these papilliferous growths attain a fair size they excrete a large amount of mucus which is voided at frequent intervals—mucous diarrhœa.

The bald-headed or plateau-like cancer, however, may exist for several months without creating any disturbances beyond causing a prolonged attack of constipation which is probably due to inertia of the muscular wall of the bowel. Toward the end of the pre-ulcerative stage, diarrhœa appears and tends to become more marked as time goes on. At first the fæces are putty-like in consistency, but later on, as the surface of the growth ulcerates, they become fluid in character, contain an excess of mucus, and bowel actions are more frequent. Bleeding becomes more pronounced, but is rarely profuse

unless portions of the growth break away. The presence of an excessive quantity of blood-stained mucus in the *fæces* is a characteristic feature of the ulcerative stage and is due to the activity of the tumour itself as also to a diffuse chronic proctitis. It is surprising how little pain accompanies an ulcerated cancer of the ampulla during the early stages of its development. When the growth penetrates the rectal wall, local suppuration in the pelvi-rectal fatty tissues may follow, and pain—sometimes of a severe character and becoming exquisite during the act of defæcation—is experienced.

At a *late* stage in the disease, large quantities of pus, mucus, blood and watery *fæces* are passed frequently by day and by night; tenesmus follows each movement of the bowels, progressive loss of weight and marked pallor are noticeable, and emaciation rapidly ensues. Later yet, owing partly to the extent of the circumferential involvement and partly to the wide fixation of the diseased segment of rectum to neighbouring viscera, or to pelvi-rectal suppuration, increasing difficulty is experienced in obtaining an action of the bowels. A time comes when the narrowed lumen of the rectum is obstructed by the inexorable spread of the cancer and by impaction in it of *fæcal* matter, so that neither flatus nor liquid slimy stools can be voided. The abdomen now slowly distends; visible peristalsis may be made out; hiccough may be intractable, and the tongue becomes coated with a thick crust of white fur. The attack of obstruction, unless relieved by *cæcostomy* or *colostomy*, usually lasts three to seven days, ending with a profuse liquid evacuation. Alternating attacks of constipation and diarrhœa will follow, heralding the onset of complete obstruction.

During this terminal stage of the disease, pain is of two types: (1) abdominal, due to paroxysmal efforts on the part of the colon to overcome the blockage in the rectum, and (2) pelvic, due to the invasion of neighbouring structures, especially the sacral plexus of nerves. Involvement of this plexus produces a constant gnawing pain over the sacrum—backache—and down the thigh along the course of the sciatic nerve—*sciatica*.

Spread of the growth to the prostate, the bladder, the vagina, or to the uterus and adnexa, adds symptoms referable to disease of these organs. Pelvi-rectal suppuration eventually leads to the formation of ischio-rectal abscesses and fistulæ. The cancerous mass may protrude

through the patulous rectum, and, breaking all confines, even sprout through the skin of the perineum to grow there luxuriantly. Finally, the appearance of nodules in the liver, of hard glands in the posterior triangle of the neck, of ascites, of jaundice, or of œdematous lower limbs, confirms the presence of generalised carcinomatosis.

Digital Examination. All malignant growths of the rectum proper are capable of being felt by the examining finger. A number of the growths at the rectosigmoid junction are beyond the reach of the finger, but some of them can be felt through the intervening rectal wall. The patient should be examined in the right or left lateral semi-prone position. Lawrence Abel (*Brit. M. J.*, 1:1927, 1937) prefers the right side to the left because, as the pelvic colon enters the pelvis on the left side, the rectosigmoid junction tends to fall downward toward the anus, whereas when the patient is on the left side the upper part of the rectum has a tendency to recede toward the abdomen.

When the growth is situated in the anal canal, it is generally found to be upon the anterior wall and small in size. The surface of the ulcer usually is deeply excavated owing to the surface necrosis induced by the constricting effect of the sphincter muscles and the levatores ani. As the result of surface sloughing, perforation of the gut wall may occur even while the growth is of limited extent, and may give rise to ischio-rectal suppuration. The association therefore of brawny induration in the perineum with a carcinomatous ulcer of the anal canal does not necessarily imply that extra-mural extension of the growth has taken place.

It should be remembered that an ampullary adenocarcinoma may extend downward and invade the anal canal.

At the completion of the digital examination, the surgeon should search the inguinal regions for any evidence of metastatic spread to the lymphatic nodes.

As previously stated, many rectosigmoidal growths can be felt digitally. Sometimes it is possible to introduce the tip of the finger into an annular growth and to test its mobility, to palpate only the hardened lower margin, to feel a mass in the lower sigmoid through the rectal wall, or, in the case of intussuscepted growth, to sweep a finger around in the deep sulcus between the malignant mass and the rectal wall (see fig. 275). On other occasions it may be impossible to

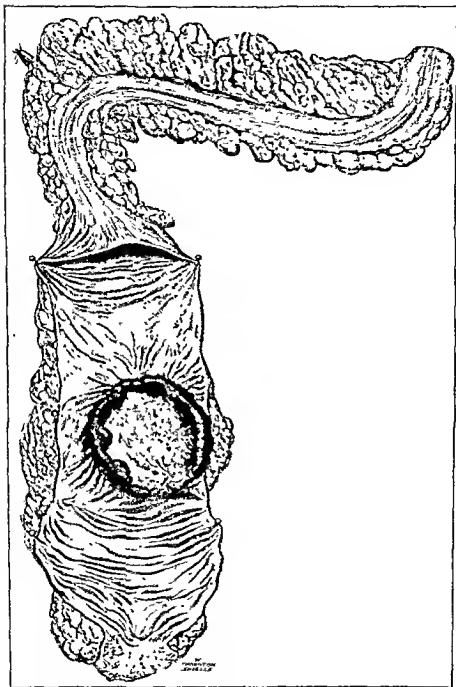


FIG. 276.—MALIGNANT RECTAL ULCER—OPERATION SPECIMEN.

feel the tumour owing to the fact that the patient will not relax during the examination.

A cancer of the ampulla can readily be felt digitally as a protuberant mass or as an ulcer with an indurated edge. If the carcinoma has developed in an adenoma or a papilloma, although a part of the mass may be soft, the portion in which the malignancy has developed is always hard and sometimes ulcerated. The polypoid malignant growths are nodular, protuberant, sessile masses which are friable and bleed freely when palpated with the examining finger. At a later stage in their development they present an ulcerated surface with overhanging indurated lips. The flat, plateau-like growth is at first movable in all directions and involves only the mucosa, but later on it presents all the typical characteristics of the malignant rectal ulcer—a crater with raised indurated everted margins (fig. 276).

As the disease progresses, the growth becomes more deeply ulcerated and more fixed, until a stage is reached when it is adherent to neighbouring structures such as the bladder, the prostate, the vagina or the sacrum. When hard globular or ovoid swollen glands can be felt in the meso-rectum, or thickened bands of malignant growth can be made out in the lateral wall of the pelvis, the case is usually inoperable. The favourable cases, thus, are the non-ulcerated mobile tumours, while the deeply excavated growths indicate that the disease is far advanced.

Proctoscopic and Sigmoidoscopic Examination. It is, of course, important to obtain visual confirmation of the presence of a growth in the rectum and sometimes, and more especially in the equivocal type, to remove a fragment of the tumour for biopsy.

Carcinomata of the lower half of the rectum should be inspected with a proctoscope, while those in the upper portion and in the recto-sigmoidal region should be viewed with a sigmoidoscope. The condition of the mucous membrane should be noted, as in most cases of cancer of the rectum, some degree of proctitis is present. During the examination the surgeon should note the following points about the lesion:

1. The position and extent.
2. The colour. The growth is of a brighter red hue than the surrounding mucosa.
3. The surface. The growth is nodular and friable when it is not

ulcerated; when ulceration has occurred, the base is often necrotic and greyish in colour.

4. The margins. The raised everted margin is quite characteristic.

5. Multiple tumours. More than one growth may be seen.



FIG. 277.—BARIUM ENEMA X-RAY EXAMINATION SHOWING FILLING DEFECT CAUSED BY A GROWTH IN THE RECTO-SIGMOIDAL REGION.

(Graham Hodgson.)

Barium Enema X-Ray Examination. Growths in the anal canal and rectum proper can readily be seen and felt, but malignant lesions of the rectosigmoid may be difficult to identify with a sigmoidoscope, especially when the field is constantly being flooded with liquid faeces and altered blood or when there is considerable spasm of the gut. It is in these cases especially, and where multiple lesions are suspected, that a barium enema X-ray examination is so helpful in diagnosis.

The skiagrams may show:

1. A filling defect (fig. 277).

2. A stricture (fig. 278); or
3. A complete obstruction. In this case the rectum is ballooned but no opaque medium passes up into the colon.

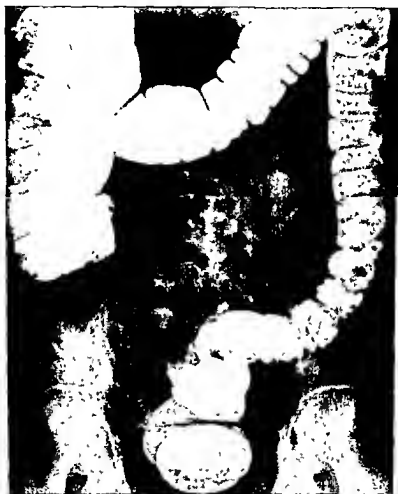


FIG. 278.—STRICTURE OF THE RECTO-SIGMOIDAL REGION PRODUCED BY A STENOSING GROWTH.
(Graham Hodgson.)

General and Abdominal Examination. As soon as the surgeon has completed the digital, rectal and the sigmoidoscopic examination and has determined the presence and extent of the cancerous lesion, he should conduct a general and abdominal examination. He should note among other things whether the patient is anæmic from the loss of blood, dehydrated by purgation and diarrhœa, yellow from sec-

ondary implants in the liver, or feeble from loss of weight. A moist clean tongue is a good sign, but a dirty furred tongue at once suggests the possibility of renal damage.

The left supraclavicular region should be searched for the presence of any enlarged glands. If these are found and are hard in consistency, it may be wise, if the primary growth appears to be operable and the patient is in good condition, to excise one of these nodes for microscopic investigation. The surgeon will occasionally be surprised to find that the excised node is inflammatory and not malignant in character.

The heart and lungs are carefully examined, and the respiration-rate, the pulse-rate, the temperature, and the blood pressure are charted.

The abdomen is next examined. It will be found to be distended in cases of colonic obstruction, and when metastatic implants are present in the liver and peritoneum. Abdominal masses may be due to faecal concretions in the large bowel or to deposits in the omentum or peritoneum. As a rule, the faecal collections are larger than the cancerous deposits. The liver should be examined to determine whether or not it is enlarged, and whether it is studded with secondary nodules.

A routine investigation of the urinary system is also carried out: the prostate is palpated, the kidneys are examined, the blood urea, the residual urine, the quality and the output of the urine are estimated, and if needs be a cystoscope is passed and pyelograms are taken. The presence of an enlarged prostate or the signs of urinary failure may play an important part in the determination of the operative treatment of rectal cancer. This point receives special emphasis from Engel (*Surg. Clin. N. Am.*, 19:1195, 1939).

DIFFERENTIAL DIAGNOSIS

The differential diagnosis must be made from the following conditions:

1. Benign tumours: (a) epithelioma—adenoma and papilloma; (b) connective tissue—lymphoma and myoma.
2. Malignant tumours arising outside the rectum and invading it from without, e.g., cancer of the cervix, cancer of the prostate, etc.

3. Implants in the pelvic shelf from carcinoma of the stomach, carcinoma of the ovary, etc.
4. Endometrioma of the recto-vaginal septum.
5. Inflammatory stricture of the rectum, *e.g.*, gonococcal, syphilitic, etc.
6. Stricture of the rectum due to the injection of phenol or other substances which are used in the treatment of hæmorrhoids.
7. Sarcoma of the rectum.
8. Burn of the rectal wall, such as may occur in the radium treatment of cancer of the cervix.
9. Diverticulitis of the distal portion of the sigmoid loop.
10. Ulcerative colitis and proctitis.

PROGNOSIS

It is universally agreed that the best treatment for cancer of the rectum consists in a wide excision of the growth together with the rectum. The prognosis depends therefore upon two main factors:

1. The patient's condition—can he withstand a severe operation?
2. The condition of the growth—can this be radically excised together with a wide margin of healthy tissue?

Prognosis Based on the Age, Sex and General Condition of the Patient.—*Age.* As would be expected, the young withstand radical excision of the rectum better than the aged, but the chances of recurrence are much greater in the former.

Sex. The risk of excision of the rectum is less in women than in men. This is probably due to the fact that the wider female pelvis permits of a readier dissection and mobilisation of the rectum and also that in women there is usually an absence of any gross urinary trouble such as obstruction of the neck of the bladder.

The General Condition of the Patient. A patient of normal weight or a thin patient with a good blood pressure and a regular pulse and one who is not markedly anæmic or dehydrated is a good operative risk, while the obese, the plethoric and the bronchitic are poor subjects for major surgical measures.

Patients who have lost a considerable amount of weight, those who are obviously anæmic, those who show signs of myocardial degeneration and those who are manifestly suffering from urinary failure are

unsuitable for radical operation. Nevertheless, many poor-risk patients with rectal cancer can be brought into the operable group by careful and judicious pre-operative preparation.

Prognosis Based on Clinical Examination. The smaller, the more movable, the more superficial and the more protuberant the neoplasm, the more likely is it to be amenable to resection; conversely, large, fixed, ulcerating, penetrating growths are likely to have spread beyond the rectal walls and to have invaded adjacent tissues, thereby negating any type of radical excision.

The anterior ulcerating rectal growths are prone to become adherent to the vagina, the bladder, the prostate, etc., comparatively early, while the posterior ulcerating growths, on the other hand, often lend themselves to resection even when the tissues in front of the sacrum are invaded by the malignant process.

Fixity, although always occasioning the gravest anxiety, does not necessarily imply inoperability. Fixation may, for instance, be due to inflammation or to the intussusception of a rectosigmoidal growth. It is well-known that the large growths of the upper rectum may fill the narrow male pelvis by their bulky mass and give a false impression of fixity.

In a general way it may be said that the prognosis is grave:

1. When with a deeply ulcerating growth in the rectum hard glands can be felt in the meso-rectum, or bands of metallic hardness can be made out in the extra-rectal tissues.

2. When there is extensive submucous thickening denoting wide invasion of the rectal wall with growth.

3. When there is cohesion to the vagina. Cattell states that it is not uncommon to find vaginal involvement with the low extensive lesions. He has performed pan-hysterectomy at the second stage of abdomino-perineal resection in sixteen patients who showed malignant involvement of the vagina, uterus, tubes or ovaries.

4. When a rectal growth extends downward and invades the anus and the skin of the perineum.

Prognosis Based on Exploratory Laparotomy. In a fair proportion of cases it is impossible to determine the operability of growths in the rectosigmoid region or the upper third of the rectum until the abdomen has been opened.

The operable growths are readily movable, there are no secondary

deposits in the liver, and as a rule no enlarged lymph nodes are palpable; if they are, they do not extend above the bifurcation of the aorta.

In all cases the nodes along the superior hæmorrhoidal blood vessels should be carefully palpated to determine the extent of glandular involvement, because the prognosis in great part depends upon the upward spread of the disease.

A growth deep down in the pelvis may be adherent laterally, or else posteriorly to the sacrum. Furthermore, it may be stuck to the bladder or to the uterus or adnexa, or coils of intestine may be seen to dip downward to become attached to the surface of the tumour. The determination as to whether this fixation is due to inflammatory causes or to malignant spread will often depend upon the surgeon's experience in rectal surgery. In any case, the prognosis is never so good in the presence of such fixation. When multiple coils of intestine are glued to the surface of the malignant mass it generally means that the case is inoperable.

The prognosis is bad when the growth has burst its confines and can be seen as bright red or pearly seedlings in the pelvic peritoneum, when the mesosigmoid is scarred and contracted by a plaque of stony hardness, and when the tubes or ovaries are firmly adherent to a cancerous tumour in Douglas's pouch. Free fluid denotes that metastatic nodules are present in the liver, in the omentum or in the peritoneum. The life-expectancy in such cases following colostomy is but six to twelve months at most, but in those cases in which resection is impossible and yet there are no signs of hepatic or peritoneal involvement, life may be prolonged as much as a year or two or even longer following the formation of an artificial anus.

Prognosis Based on Pathological Investigations. A reliable prognosis may be formed after a study of the pathology of the excised tumour.

Broders (*Minnesota Med.*, 8:726, 1925; and *Med. J. & Rec.*, 121:133, 1925) divides adenocarcinomata of the rectum into four groups of malignancy according to the degree of differentiation of the tumour cells. Broders' well-known method measures the *rate* of growth—histologic malignancy grade.

Dukes (*J. Pathol. & Bacteriol.*, 35:323, 1932), on the other hand, measures the *distance* reached by the growth—A, B, and C classifica-

tion. Dukes, after his examination of the specimen, gives a detailed description of the size and position of the lesion, its extent and spread by direct continuity, by venous channels and by the lymphatic system, as well as an account of the microscopic characters and rate of growth. He divides rectal cancer into three groups:

A cases, in which the growth is limited to the rectal wall;

B cases, in which there is spread by direct continuity into the perirectal tissues but there are no metastases in the regional lymph nodes; and

C cases, in which metastases are present in the regional lymph nodes.

The practical value of this method of classification will be readily appreciated by reference to tables 1 and 2 (see page 1275).

Gabriel, Dukes and Bussey (*Brit. J. Surg.*, 23:395, 1935) made the suggestion that *C* cases should be subdivided as follows: *C1* cases, in which a certain number of non-malignant glands are present at the upper end of the ligatured vascular pedicle; *C2* cases, in which metastases are present in the glands up to the level of the ligature of the superior hæmorrhoidal blood vessels.

Prognosis Based on St. Mark's Hospital Statistics. Gabriel, in the *British Encyclopædia of Medical Practice* supplied us with the following valuable statistical data:

The operative risk of perineal excision of the rectum is now only 5% or less, although it appears in Table I as 7% for the total group; the relation of the mortality to the stage of the disease is evident.

TABLE I

OPERATION MORTALITY AFTER PERINEAL EXCISION
OF THE RECTUM (St. Mark's Hospital)

Classification of Tumour	Submitted to Operation	Died from Operation	Operation Mortality (Per Cent)
Group A ..	46	0	0.0
Group B . . .	100	5	5.0
Group C . . .	140	15	10.7
Total .. .	286	20	7.0

The operative mortality of combined excision of the rectum is certainly higher, and this must be the case if fairly advanced cases are undertaken.

Out of 14 A and B cases 13 reached the 5-year period, but out of 11 C cases only 4 survived. The figure of 68% of 5-year survivals for the total is almost identical with that of 69.3% reported by Abel for a series of 150 abdomino-perineal excisions traced over a period of 5 years.²

OPERABILITY-RATE

Gabriel (*Prognosis*, 2:153, 1937) states that at St. Mark's Hospital for the years 1921 to 1931 the operability-rate was 54 per cent, during 1934 the rate was 53 per cent, and for 1935 it was 60 per cent. High operability-rate was achieved partly by a judicious selection of operation, *i.e.*, a perineal excision for lower third tumours, perineo-abdominal excision for advanced and upper third tumours, and partly by a policy of not rejecting any borderline cases as inoperable without first resorting to exploratory laparotomy. Cattell's remarks on this point are interesting:

In the 10-year period from 1922-1931 inclusive, the operability-rate in carcinoma of the rectum varied between 47.6 and 55.6%. In 1932 64% were submitted to resection. Since that time the operability has increased still further, varying between 70 and 75%. These operability-rates have been determined on the basis of all patients examined at the Clinic in whom a diagnosis of carcinoma of the rectum was made, including those patients with such advanced disease that no operative procedure was advised. In other words, during the latter period over 70% of the patients seen had some type of rectal resection.³

OPERATIVE TREATMENT

"I never know until the abdomen has been opened and exploration has been completed what type of operation best suits the individual case" (C. W. Mayo).

Surgical treatment consists of an adequate radical resection of the rectum, as this offers the patient with cancer of the rectum the greatest prospect of cure. It is true that an occasional brilliant success has been achieved by the employment of deep X-ray therapy, radium or diathermy; but it is generally conceded by those who are best able to judge that these agents are uncertain in their action, bizarre in their effects, and yield results which can in no way compare with

² Gabriel, *Brit. Encycl. Med. Pract.*, 10 552, 1938.

³ Cattell, *Surg. Clin. N. Am.*, 18 747, 1938. Courtesy of W. B. Saunders Co.

those obtainable by the well-trying and perfected surgical measures of the present day.

Gordon-Watson, with his great experience of the radium treatment of cancer of the rectum, made the following important statements in his Bradshaw Lecture, 1937:

For some years I endeavoured to find a way out with radium, and indeed this can and has been accomplished in a small proportion of operable cases with some brilliant results. I have, however, come to the conclusion that the results are too uncertain to justify its use for an operable case with our present knowledge, except when a radical operation is contra-indicated on general grounds. In several instances, though in a small proportion, I have reduced fixed inoperable cases to a state of complete quiescence, if not cure. Some of these patients remained in good health for periods ranging from 7-10 years.

With radium en masse I have no personal experience. Today research is busy with giant bombs and X-ray plants working up to a million volts. Mottram (*Brit. J. Radiol.*, 9:108, 1936) has shown experimentally that, during treatment by radiation, sensitivity rises and falls, and affirms that if treatment could be spaced so as to catch the tumour always at times of high radio-sensitivity and avoid times of high radio resistance, better results would be assured. If this be true, then the flexibility of these stupendous generators of gamma and X rays may open the door to results hitherto unobtainable.*

Although everyone will agree that definite progress has been made in recent years in radiation therapy, alone or in conjunction with surgery, the efficacy of this method of treatment cannot as yet be justly evaluated. We at least do know from massed statistics what incomparable success surgery can achieve in the treatment of rectal cancer; and we can say this with full warrant, that when the correct procedure is selected for the individual patient, operative measures can claim between 50 and 70 per cent of five-year cures. The selection of the correct operation is often a matter of personal judgment in *each individual case and is in part influenced by such factors as the* general condition and age of the patient, the situation and the size of the tumour, the estimated extent of the disease, the fixity of the lesion, and the surgeon's experience in rectal surgery.

CHOICE OF OPERATION

The various operations for cancer of the rectum as practised to-day may be conveniently classified under the following headings:

* Gordon-Watson, *Proc. Roy. Soc. Med.*, 28:1251, 1935.

A. For Operable Cases.—1. *Radical Resection of the Rectum with Permanent Colostomy:*

- (a) Abdominal resection (Hartmann).
- (b) Perineal excision (Lockhart-Mummery).
- (c) Combined radical operations: (i) Abdomino-perineal excision (Ernest Miles); (ii) Abdomino-perineal excision in two stages (Lahey); and (iii) Perineo-abdominal (Gabriel).

2. *Conservative Resection of the Rectum with Preservation of the Anal Canal and Anal Sphincters.*

- (a) Abdominal resection with sutured anastomosis (Devine).
- (b) Perineal excision (Pauchet).
- (c) Combined abdomino-anal operation (Aldrich-Blake and Hochenegg).

B. For Inoperable Cases.—*Colostomy*, the growth being attacked when possible with radium, X-rays or diathermy.

As over two-thirds of rectal cancers are situated in the upper third of the rectum or at the rectosigmoidal junction, it will be readily appreciated that a combined excision, such as an abdomino-perineal or a perineo-abdominal, is indicated in fully 70 per cent of the operable cases.

Perineal excision with permanent colostomy, after the method of Lockhart-Mummery, is frequently selected for elderly, feeble or obese patients with low rectal tumours.

Hartmann's operation is a safe and bloodless procedure and is sometimes advised for those lesions which are situated at or preferably above the peritoneal reflection.

There is increasing scope for conservative resection of the rectum with preservation of the anal sphincters, and I venture to suggest that these operations will undoubtedly be more widely practised in the future.

For an early growth of the lowest part of the sigmoid loop or of the rectosigmoidal region, Devine's methods of operating upon the de-functioned distal colon are both sound and practical and would appear to be gaining rapidly in popularity.

TECHNIQUE OF THE OPERATIONS

1. **Abdominal Resection—Hartmann's Operation.** The operation of abdominal resection was first described by Hartmann (*Cong. franç. chir.*, 30:411, 1923), and in the particular circumstances which I shall indicate this would seem to be a sound procedure for excision of growths of the rectosigmoidal junction which are situated above the peritoneal reflection.

The operation aims at removal of the tumour, its lymphatic drainage right up to the aortic bifurcation, approximately 2 inches of healthy bowel below it, and the major portion of the sigmoid colon. The operation is easier, quicker to perform and is attended with far less shock than the combined abdomino-perineal methods. It is almost bloodless and there is no need to alter the position of the patient on the operating table. All the inconveniences of a large perineal wound, which takes a long time to heal satisfactorily, which requires daily dressings, and which involves the risks of urinary infection, prolonged sepsis and perhaps secondary hæmorrhage, are avoided, and the period of convalescence is shortened by at least half. The patients are usually easy to nurse and can move about in bed as freely as after any other abdominal operation.

There is no suggestion here that this procedure is equally as good or as radical as a combined excision, "but I have performed this operation frequently for many years and with a low mortality. In no instance following Hartmann's operation have I met with any secondary downward spread or recurrence in the stump. I am convinced that many lives have been cut short unnecessarily by a combined operation, lives that could have been prolonged and perhaps saved altogether by this less severe but entirely adequate operation for growths in this situation" (Gordon-Watson).

The operative death-rate is low. In Muir's series (*Lancet*, 1:1094, 1939) of nine cases there were no deaths although a number of his patients were aged, obese or frail. In Rankin's series (*Surg., Gynec. & Obst.*, 46:537, 1929) of twenty-six patients there was but one death.

The all-round mortality of this operation, even in poor subjects, is probably in the region of 5 per cent.

Hartmann's operation is specially indicated when a rectosigmoid

growth is situated above the peritoneal reflection and when the patient is aged, debilitated, obese or otherwise unfit to withstand such a severe radical operation as that of Miles or even of Lahey. Muir maintains that it is the method of choice for the advanced and adherent growths of the upper part of the rectum and of the recto-sigmoidal junction. "It is here that I believe the operation to be particularly valuable in that its use will raise the operability-rate of rectal cancer. It may be argued that no attempt should be made to remove an advanced and adherent growth. This is a matter of opinion; adhesions may be inflammatory, and palpable glands are often free from growth. I do not consider that involvement of the bladder, or of one ureter, or even a small secondary deposit in the liver should necessarily contra-indicate the removal of the primary growth."

The operation is performed as follows: The patient is placed in the full Trendelenburg position, and the abdomen is explored through a large left low paramedian incision. After a thorough exploration of the abdominal viscera has been conducted and after having decided that the case is suitable for the performance of a Hartmann operation, the sigmoid loop is liberated, the peritoneum of the mesosigmoid is incised both medially and laterally, the superior hæmorrhoidal vessels are ligatured close below the aortic bifurcation, and the rectum is lifted boldly forward from the hollow of the pelvis with the fingers. The two peritoneal incisions on either side of the mesosigmoid are extended downward until they meet in the mid-line at the base of the bladder in the male and at the level of the cervix in the female. The rectum is separated anteriorly from the prostate or vagina, and after dividing the lateral ligaments a great degree of mobility of the rectum is obtained; in fact, it is often possible to mobilise the rectum to such an extent that the growth can be brought to the level of the abdominal wound.

Two large right-angled forceps, such as are sometimes used in the operation of pan-hysterectomy, are applied to the ampulla of the rectum fully 2 inches below the growth, and the bowel is divided between them with a cautery. The upper cut end of the rectum embraced in the clamp is now drawn through the wound and a triple de Martel clamp is applied to the sigmoid colon at the point selected for the transection (fig. 279). The middle blade is removed and the

gut between the two remaining blades is burned through with a cautery.

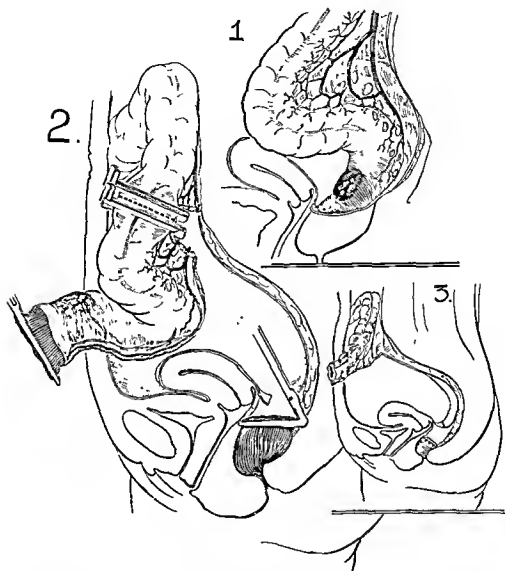


FIG. 279.—ABDOMINAL RESECTION OF A GROWTH SITUATED IN THE RECTO-SIGMOIDAL REGION WITH PERMANENT COLOSTOMY—HARTMANN'S OPERATION.

The end of the sigmoid colon embraced in the clamp is next drawn through a stab wound made in the left iliac fossa to act as a terminal colostomy. The rectal stump is oversewn and invaginated and the pelvic floor reconstructed by stitching together the two leaves of peritoneum with a continuous catgut stitch. Drainage is not pro-

vided except in those cases where there has been considerable oozing. In these cases a Penrose drain is led through the suture line in the peritoneum of the reconstructed pelvic floor down to the rectal stump and emerges through the lower end of the abdominal incision. A few sutures anchor the colostomy in position, and the clamp on the exteriorised stump of colon is removed in twenty-four to forty-eight hours.

2. Perineal Excision—Lockhart-Mummery's Operation. The first detailed description of this operation which was devised by Lockhart-Mummery, was given by him in the *Lancet* in 1920. Since that date he has on several occasions written most forcefully upon the indications and contra-indications, upon the advantages and limitations, and upon certain improvements in technique which he has from time to time introduced with the object of making the operation simpler, quicker, safer, and more radical in its scope. I have read many of these articles and I am of the opinion that the best descriptions of his methods of dealing with rectal cancer are found in his book, *Diseases of the Rectum and Colon* (2nd ed., 1934) and in his more recent contribution to *Surgery, Gynecology and Obstetrics* (67:655, 1938). He writes:

Although the method of excising the rectum by the perineal route, which goes by my name, has now become the standard practice for suitable cases of cancer of the rectum, I have never suggested that it is the only method of removing the rectum or that it should be practised to the exclusion of other methods. I have, it is true, used the perineal two stage method of excising the rectum in most of the cases that I have treated, but when another method seemed for some reason or another better suited to the particular case, I have always adopted that method which seemed to me to give the patient the best chances.

He further points out that his method is suitable in any case where the malignant tumour is confined to the rectum proper and where the examining finger can reach beyond the upper limits of the growth. In those cases where the carcinoma is situated in the recto-sigmoidal region or in the uppermost reaches of the rectum, he would advise a more radical undertaking, such as a combined perineo-abdominal, as practised by his colleagues at St. Mark's Hospital.

There are many instances of carcinoma of the rectum in which the patient is unquestionably a bad surgical risk because of old age,

obesity, debility or accompanying disease, and in such cases, if there is a reasonable chance of eradicating the disease completely by the method about to be described, this is to be preferred. It is often feasible by the two-stage perineal excision method to cure cancer in a patient who has but little chance of survival if treated by a combined abdomino-perineal excision. The operative death-rate, too, is lower than for any other method of excising the cancerous rectum. Lockhart-Mummery showed that in his last series of 150 cases the mortality was only 4 per cent, and that in a total series of over 500 cases treated by perineal excision of the rectum there were 55 per cent of five-year cures.

About one hour before operation, twilight sleep is induced by an injection of omnopon and scopolamine, a spinal anæsthetic being given when the patient arrives in the operating room. The operation is best performed in two stages, *viz.*, first stage—exploration of the abdomen and colostomy; second stage—perineal excision of the rectum, which is carried out about fourteen days later.

First Stage—Exploration and Preliminary Colostomy. A small left vertical sub-umbilical incision is made through the outer fibres of the rectus muscle, sufficiently large to admit the surgeon's hand. After the digital exploration has been completed and the surgeon has satisfied himself that there is no bar to the performance of this operation, the sigmoid loop is picked up and withdrawn through the abdominal incision. Until recent years it was customary to pass a glass rod through the mesocolon near the apex of the loop and then to fashion a simple loop colostomy. But latterly it has been thought better to transect the sigmoid colon and to implant the ends of the bowel into the upper and lower portions of the wound so that the two openings are separated by at least 1 inch of skin. The main disadvantages of the simple loop colostomy are:

(a) The spur tends in time to retract, and this is specially noticeable if the patient gains in weight after the operation, which many do.

(b) Even with a well-fashioned colostomy, fæces often succeed in passing from the proximal opening along the arched mucous face of the gut to the distal opening and tend to accumulate in the blind colonic pouch. This accumulation may lead to fæcal impaction, to colicky abdominal pains, and to a troublesome mucus discharge on to the skin of the abdominal wall through the distal stoma. Again,

the pent-up faecal matter may prove most difficult to dislodge despite repeated enemata.

When possible therefore it is advisable to make a double-barrelled colostomy and to place the divided ends of the bowel as far apart as possible so that soiling of the distal segment may be avoided.

The proximal colon is drawn taut until no more bowel can be pulled downward through the wound, while the lower end of the redundant sigmoid is replaced into the pelvis. This manœuvre of allowing a lot of slack gut to prolapse into the pelvis will simplify the mobilisation of the bowel at the second operation and will also permit the removal of a long segment of colon above the malignant mass in the rectum.

The double-barrelled colostomy is made in the following manner: A point on the sigmoid colon is chosen for the transection, and a small vertical incision, about 2 to 2½ inches long, is made in the mesosigmoid, commencing close to the bowel and extending downward; the blood vessels which are encountered are secured and ligatured; two crushing clamps are applied side by side to the bowel which is then cut through with a canter; the clamps are widely separated so that the proximal stump of gut is drawn to the upper part of the wound, while the lower stump is made to lie at the lower part; the ends of the gut embraced in the clamps are made to project at least 2 inches above the skin margins; in the gap between the two limbs of colon the edges of the peritoneum are approximated by a continuous running catgut stitch, the needle of which also picks up portions of the cut edge of the mesentery; and the margins of the cut rectus muscle and aponeurosis and the skin incision are drawn together over the sutured peritoneum to fill the gap between the issuing limbs of the colon. Great care is taken to see that neither limb is unduly constricted and that the blood supply is quite adequate. It will be noted that neither the proximal nor the distal portion of colon is sutured to any layer of the abdominal wall.

The incision is now hermetically sealed off with adhesive waterproof sheets, and the projecting stumps of colon embraced in the clamps are surrounded with gauze dressings. Before the bandages are applied, one or two puncture holes are made with a cautery in the proximal stump of gut wall beneath the crushing blade to ensure that there will be a ready escape of all pent-up gases in the colon. The

clamp on the upper or proximal stump is removed in forty-eight hours, but the lower clamp is left in situ until it cuts its way through and works loose. The two limbs of colon become firmly adherent to the abdominal incision at the end of the second day after the operation, and subsequent retraction toward the abdominal cavity is minimal and insignificant. As a rule the colostomy does not discharge any fecal matter until the third or fourth post-operative day. The adhesive dressings are removed on the eighth day after operation. The skin stitches are then withdrawn, and fresh protective dressings are sealed into position.

As soon as the clamp in the distal stump cuts through, the rectum is flushed out with weak antiseptic solution, and crude cod-liver oil is instilled into the bowel to reduce its bacterial content.

About a fortnight after the performance of the colostomy, when the abdominal incision has firmly healed, when the proximal stoma is functioning in a satisfactory manner, when the rectum has been cleansed and much of the inflammatory reaction around the growth has subsided, and when there is an all-round improvement in the patient's condition, the second part of the operation is carried out.

Second Stage—Excision of the Rectum. If the patient is a male, a No. 8 gum-elastic coude catheter is passed, tied into position, and the bladder emptied as soon as the spinal anæsthetic has taken effect. This catheter acts as a very useful guide to the urethra during the anterior dissection. If the patient is a female, a self-retaining catheter is used, and this is kept in situ during the operation and for the first three or four days following operation.

Perineal excision of the rectum is carried out with the patient in the left lateral semi-prone position, although some surgeons prefer an exaggerated lithotomy position. Good exposure is obtained by placing a large flat sandbag underneath the left hip; by drawing the buttocks slightly over the edge of the operating table; by separating the knees; by supporting the arms and by throwing the beam of a strong spotlight on to the perineum. Cotton wool is packed between the thighs to prevent blood from trickling down the legs during the course of the operation.

The anal region and perineal skin are thoroughly cleansed with ether and then painted with tincture of iodine and alcohol or with metaphen. The assistant now closes up the anus with two purse-string

sutures of stout silk so that no leakage can occur while the rectum is being excised. The skin area beyond the operation site is sealed off with adhesive waterproof sheets, and the skin incision is then made. This starts from the base of the sacrum in the inter-natal cleft and is carried forward so as to surround a wide margin of peri-anal skin, to finish about 1 inch in front of the knot of the second purse-string suture (fig. 280).

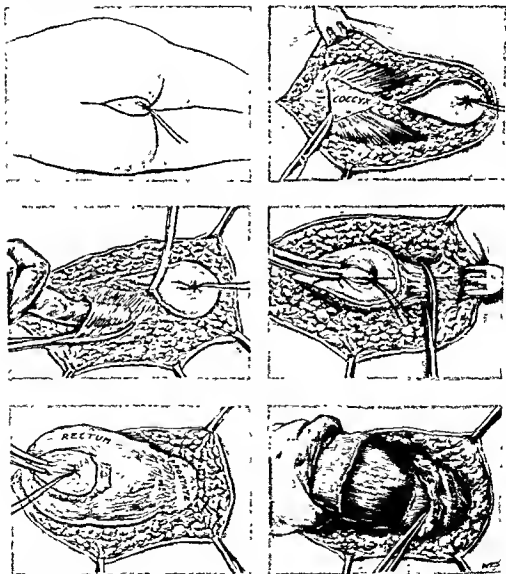


FIG. 280.—LOCKHART-MUMMERY'S OPERATION OF PERINEAL EXCISION OF THE RECTUM WITH PERMANENT COLOSTOMY—PERINEAL PORTION OF THE OPERATION.

The incision is deepened into the loose fatty and connective tissue of the ischio-rectal fossæ, and the coccyx is displayed and disarticulated at the sacrococcygeal joint. After the coccyx has been cut away from its moorings, the tense deep fascia beneath it is incised on either side and the index finger of the left hand is insinuated beneath the flat levator ani so as to guard the rectum while this muscle is being divided with scissors. Each levator muscle is completely divided from behind forward to a point in front of the sutured annus. The dissection is simplified if the lower, *i.e.*, the left, muscle is cut through first. All bleeding points are picked up at this stage and tied off with No. 1 plain catgut.

The next step in the operation, and perhaps the most difficult one, consists in freeing the rectum anteriorly from the prostate or vagina. This part of the dissection must be carried out boldly with blunt-pointed scissors, and care should be taken not to inflict any injury on the rectum behind or the urethra or vagina in front. In the female the posterior aspect of the vaginal wall is defined and freed upward until the peritoneal reflection is encountered, while in the male the dissection is carried up between the rectum and the posterior wall of the urethra.

The catheter in the urethra can be felt with the finger and this, as already stated, acts as a helpful guide. There is a tendency at this stage of the operation to dissect toward the rectum in order to avoid wounding the urethra. If this is done, it is more than likely that the rectum will be punctured or lacerated. It is better to dissect close to the urethra, but on no account should the dissection be extended in front of the prostate. The prostate should be reached about 2 to 3 inches from the skin margin, and can be readily felt with the finger.

The anterior wall of the rectum is only loosely adherent to the prostate. When the lower half of the prostate comes into view, it is a simple matter to sweep the rectum completely away from the gland in front and from the vesiculæ seminales which straddle the prostate above. It is most important to keep the dissection well behind both the vesiculæ seminales, otherwise there is considerable danger of injuring the trigone of the bladder. When the vesiculæ seminales have been clearly defined, the rectum is pulled backward to display the small pouch of peritoneum which dips downward in this region,

between the bladder in front and the bowel behind. The peritoneum close to the rectal wall is picked up with a pair of dissecting forceps, put on the stretch and cautiously snipped with scissors (fig. 281).

The small opening in the peritoneum is now carefully enlarged and a long roll of gauze is gently insinuated upward to prevent blood from entering the peritoneal cavity and coils of intestine from slipping through into the wound in the peritoneum. The edges of the peritoneum are picked up with long slender artery forceps and then divided with scissors, cutting very close to the rectum as far backward as possible on both sides.

The rectum is then drawn firmly downward, and its strong fascial attachments laterally and behind are divided freely. The fingers of the right hand are passed upward behind the posterior rectal wall and the sacrum, and the rectum, together with its fatty envelope, is lifted forward away from the arching surface of the bone until the promontory of the sacrum can be felt.

During this manœuvre care is taken not to injure the middle sacral vessels as they course downward on the middle of the exposed face of the sacrum. The rectum should now be quite free except, of course, at its attachment to the sigmoid colon.

At the next stage, the superior hæmorrhoidal blood vessels should be ligatured and divided as high as possible in the fatty mesosigmoid. The rectum is again drawn tautly downward, the fingers of the left hand search for the broad vascular pedicle, and when it is identified a large curved aneurysm needle threaded with stout silk is passed through the pedicle (as close to the gut as possible), the pedicle then being tied off and divided.

As soon as this is done, the liberated lower segment of sigmoid colon can be drawn freely into the perineal wound. Lockhart-Mumery prefers to clamp the mesosigmoid with long curved hæmostats and after dividing the pedicle to ligature it in two places with strong catgut. The blades are rotated laterally while the ligature is being applied. The mobilised colon should then be inspected and divided at a point where the blood supply appears to be quite adequate.

The rectum is surrounded with swabs, the edges and the depth of the wound are protected with cellophane gauze squares, and the bowel is put on the stretch. A circular incision through the sero-muscular coats of the colon is next made down to the mucous mem-

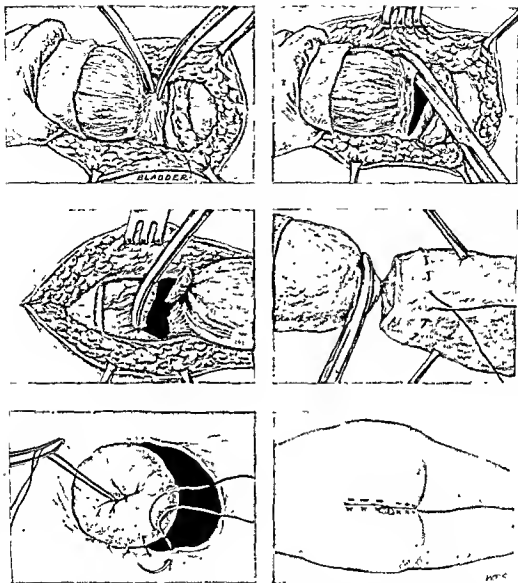


FIG. 281.—LOCKHART-MUMMFY'S OPERATION OF PERINEAL EXCISION OF THE RECTUM WITH PERMANENT COLOSTOMY—PERINEAL PORTION OF THE OPERATION.

brane, and a cuff of mucosa is fashioned by stripping back the outer coats of the bowel. The cuff is ligatured with chromic catgut, two Allis forceps steady the colon, while the purse-string suture is inserted $\frac{1}{2}$ to 1 inch above the ligature, the curved clamp is applied to the cuff about a $\frac{1}{2}$ inch distal to the ligature to prevent spillage while the mucosa is being burned through with a cantery, and the purse-

string suture is drawn taut at the moment when the mucosal stump and adjacent bowel wall are being invaginated (see fig. 281).

The ends of this purse-string suture are left long and seized with artery forceps to act as a tractor while the closed stump of colon is being sutured to the cut margins of the pelvic peritoneum. The flat swabs and the roll of gauze which were inserted into the peritoneal cavity are now removed. Using a long needle-holder and curved atraumatic needle threaded with No. 0 or No. 1 twenty-day chronic catgut, the opening in the peritoneum is closed in the following manner: The stitch starts on the lower lateral aspect so as to close its lower corner, the peritoneum being sutured to the stump of the colon outside the peritoneal cavity. As a rule, the needle picks up two bites of peritoneum to one bite of bowel wall. When the suture reaches the middle line anteriorly, another suture is started from the opposite corner, and when this meets its fellow they are tied together. It is important to introduce the sutures very close to one another so that no gap remains in the pelvic floor through which a knuckle of small intestine might insinuate itself and thus become strangulated. The large gaping wound is swabbed out with mild antiseptic solution and any obvious bleeding points are seized and ligatured.

A large flat piece of thin rubber sheeting is then pushed into the depths of the wound, and this is lightly packed inside with gauze. The folded edges of this piece of rubber tissue are brought out as a drain in the centre of the skin incision, and the edges of the skin above and below the projecting drain are drawn together with a series of interrupted vertical mattress sutures of fine silk.

Post-Operative Treatment. As this operation usually takes from twenty-five to forty-five minutes to perform, is relatively bloodless and is accompanied by very little shock, there is rarely any need for blood transfusions. The dressings and packing are withdrawn on the fourth day after operation; the large wound is not irrigated with antiseptic solutions unless it becomes frankly septic; when the wound is healing a small rubber tube is inserted to drain away any collections of serum; and the skin stitches are removed on the eighth day. On the tenth to the fourteenth post-operative day, in order to accelerate healing of the wound the patient should be advised to take a hot bath daily. He should be fit to return home about three to four weeks after the perineal excision.

In female patients a self-retaining catheter is kept in position for three or four days to prevent over-distension of the bladder, but in males it is better to catheterise the patient eight-hourly for the first few days following operation or to employ Dukes's apparatus (as made by Corry, of London). After the period of catheterisation is over, normal micturition should be encouraged by intramuscular injections of esmodil.

3. The One-Stage Radical Abdomino-Perineal Operation—Miles's Operation. This is the radical operation for rectal cancer and aims at removing as completely as possible all the tissues comprising the three zones of spread. By this method the following are removed: (a) about three-quarters of the sigmoid loop together with the whole of the rectum encased in its sheath of fascia propria; (b) the whole of the pelvic mesocolon; (c) the peritoneum lining the floor as well as the walls of the true pelvis; (d) the whole of the levatores ani and coccygeus muscles; (e) the external sphincter muscles of the anus and as much as possible of the ischio-rectal fat and a wide area of the peri-anal skin.

Miles introduced this operation in 1907. He wrote many articles dealing with this method (*Brit. M. J.*, 2:941, 1910; *Brit. J. Surg.*, 2:292, 1914; *Tr. M. Soc.*, 46:127, 1922, etc.), but in my opinion the best descriptions of his one-stage abdomino-perineal operation are to be found in his book, *Cancer of the Rectum* (1926) and in the work, *Post-Graduate Surgery* (ed. 1, p. 1453, 1936) of which I was the editor. The illustrations which were drawn by Maxwell for his classic paper in the *British Journal of Surgery* (1914) have been reproduced in many text-books on operative surgery and in monographs dealing with rectal and abdominal operations. Lawrence Abel, his apt and brilliant pupil, and also T. E. Jones have done much to popularise this operation by their exquisite craftsmanship, by the results they have achieved and by their inspiring teachings.

There are many modifications of Miles's operation, most of these being two-stage abdomino-perineal procedures, as described by Coffey (*Am. J. Surg.*, 14:161, 1931), Rankin (*J. Am. M. Ass.*, 89:961, 1921), Bartlett (*Arch. Surg.*, 22:786, 1931) and Lahey (*Surg., Gynec. & Obst.*, 51:692, 1930). One of these two-stage radical resections will be considered presently (see page 1309). The two-stage abdomino-perineal operation is nothing more nor less than the one-stage opera-

tion performed in two stages with an interval of a fortnight or so between them.

In discussing the operability-rate of the abdomino-perineal operation Miles writes:

"I find that after excluding not only the cases in which the local disease is too far advanced, but those, at any stage of the disease, in which age, general condition, or low cardiac energy index, indicate bad operation risks, the operability-rate among the cases that come under my observation is about 35 per cent."

The operative death-rate varies from 10 to 25 per cent; in Miles's hands it is about 10 per cent. Statistics compiled by Lawrence Abel (*Surg., Gynec. & Obst.*, 60:481, 1935) on a five-year basis from cases, including all varieties, operated upon at the Royal Cancer Hospital, show a survival-rate of 69.3 per cent. These figures are in many respects similar to those submitted by T. E. Jones (*Surg., Gynec. & Obst.*, 62:415, 1936), who, in a personal series of 151 cases, had a mortality of 10.5 per cent, while in his follow-up he found 52 per cent of the patients living and well after five years, 62 per cent after three to five years, and 70 per cent after one to three years.

Miles attributes his low operative mortality to three main factors:

(a) The employment of spinal anæsthesia.

(b) The estimation of the cardiac energy when assessing operability.

(c) The adoption of blood transfusion as a routine measure immediately after the completion of the operation.

He points out that although the abdomino-perineal operation is comprehensive in its aim, it should not be reserved for advanced cases only. "It should be the procedure of choice for early cases; in fact, the earlier the better because then we may hope to circumvent the invisible spread of the disease. Should it be reserved for advanced cases only, as advocated by some, then the invisible spread will have advanced beyond the confines of the operation field and recurrence will be inevitable. The operation is a surgical procedure of the first magnitude and importance, and should not be undertaken unless the patient's general condition is satisfactory."

In order to ensure a successful result, attention should be paid to:

(a) The preparation of the patient before operation.

(b) The choice of anæsthesia.

(c) The details of the after-care.

Stanley Aylett, who was at one time resident surgical officer to the Gordon Hospital for Diseases of the Rectum and Colon, has given a most instructive, detailed and lucid account of the treatment before and after the Miles one-stage abdomino-perineal operation. Here is his description of the pre-operative treatment:

Patients with a minimal amount of obstruction, as shown by periodic constipation and diarrhoea and perhaps some slight abdominal distension, are admitted at least ten days before the date of operation. Those with more obstruction have longer preliminary treatment, and in over 90 per cent of cases a first-stage cæcostomy can be avoided.

On the morning of admission the patient is given 1 oz. of *mist. alba*, followed by hourly $\frac{1}{2}$ -oz. doses for five hours. A further $\frac{1}{2}$ -oz. of the mixture is given on each succeeding day until forty-eight hours before the operation. Each morning and evening the patient is given a rectal wash-out with about $1\frac{1}{2}$ pints of plain water, the last treatment being on the morning before the day of operation. In giving the rectal wash-out it is often impossible, because of the obstruction caused by the growth, to run in more than a few ounces at a time.

During this period the patient is fed on a normal diet with the addition of plenty of fluids and glucose. On the day before the operation a light diet is instituted, and on the following morning a glass of glucose and barley water is given. Thus no purgatives or wash-outs are administered for fully twenty-four hours before the operation, and during this period the bowel is kept at rest as much as possible. Except for the last four or five days the patients are allowed up in the usual way and are permitted to leave hospital for gentle exercise. During the latter part of the preliminary pre-operative treatment, however, they are allowed up only to wash and bathe. An intestinal antiseptic, such as dimol or salol 5 grains twice daily, is usually given, and on the night before the operation sleep is assured by giving 10 grains each of medinal and aspirin.

Various tests are carried out on the patient. The hæmoglobin and blood count are estimated; if they are low, intra-muscular injections of campolon are given and ferrous sulphate tablets, two t.d.s., administered by mouth. In severe cases of anæmia 1 or 2 pre-operative transfusions are of benefit in making the patient safe for operation. The urea concentration and the blood urea are determined. In cases in which the results are above the borderline of safety an extended period of preliminary treatment helps to bring these values nearer to normal, and especially the blood urea is lowered by the relief of the intestinal obstruction. In all cases a Wassermann test is carried out and the urine examined.

A useful index of the safety of the operation is the cardiac index, which is the quotient obtained by dividing the pulse pressure by the diastolic pressure

and multiplying the result by 100. A patient with an index of less than 25 is a very severe risk, the operation usually being fatal, and the mortality is increased when the quotient is above 75.

In cases admitted with acute obstruction, or in which it develops during the preliminary treatment of cleaning the bowel, a cæcostomy must be performed at once; and, after the bowel has been drained for several days, wash-outs can be carried out through this opening as well as through the rectum.

An hour before the operation a hypodermic injection of omnopon gr. 1/3 and scopolamine gr. 1/150 is given, and shortly afterwards a catheter is passed and is retained. This is essential so that the bladder may be completely emptied when the patient is on the table, for any distension whatsoever materially hinders the manipulations deep down in the pelvis at the operation. The patient is anaesthetised in bed with pentothal sodium; intravenous anaesthesia and spinal anaesthesia are given in the theatre with a 1 in 1500 solution of percaïne, the Etherington Wilson technique being used. After this, pressure is made with the fist on the supra-pubic region and the catheter is slowly withdrawn. It is necessary to maintain pressure until the withdrawal is complete, for, if this is not done, air is sucked into the bladder, and the hindrance produced by this is the same as if the organ were filled with urine.^a

The Abdominal Portion of the Operation. The patient is placed in the Trendelenburg position and the abdominal cavity is opened through a long right paramedian incision which starts from the crest of the pubis and extends upward to a point one inch or so above the umbilicus. The skin margins are protected in the usual manner, and a suitable self-retaining retractor is inserted to keep the edges of the wound widely separated during the abdominal portion of the operation.

The abdominal and pelvic exploration is carefully and methodically conducted, and if there is no contra-indication to the performance of this procedure the intestines are packed away out of the field of operation, the pelvic colon is drawn through the wound, and the position of its blood vessels in the mesocolon is noted. There may be some difficulty in doing this, owing to the sigmoid loop being adherent by white filmy adhesions to the floor or, more frequently, to the lateral wall of the pelvis. When such adhesions are encountered they should be snipped through with scissors on the outer side of the pelvic mesocolon so as to mobilise the adherent portion of the colon and thus permit of its being easily delivered outside the abdominal cavity.

^a Stanley Aylett, *Lancet*, 2 1516, 1938.

The next step in the operation consists in applying a strong ligature to the inferior mesenteric artery at the seat of election, *i.e.*, between the first and second sigmoidal branches.

When the pelvic mesocolon contains little fat the position of these vessels can be seen readily, and there is no difficulty in applying the ligature at the correct spot, but in obese subjects the vessels cannot be seen. Under these circumstances it is advisable to place the ligature on the inferior mesenteric artery at the level of the bifurcation of the abdominal aorta, as that point is half an inch below the origin of the first sigmoidal branch, and well above the origin of the second branch.

It is never necessary to expose the vessels by dissection, as, by so doing, somewhat free bleeding may ensue from branches of the sigmoidal veins which obscures the view and embarrasses the operator. The simplest way is to transfix the pelvic mesocolon by passing an aneurysm needle behind the inferior mesenteric vessels at the level of the bifurcation of the aorta and then to ligature the mesocolon en masse. When applying this ligature the position of the left ureter must be borne in mind.

At the level of the bifurcation of the aorta the ureter is from three-quarters of an inch to an inch to the left of the inferior mesenteric artery, but at the level of the promontory of the sacrum they are close together, so that if the mesocolon is transfixed too low down the ureter is in danger of being included.

Ligature of the inferior mesenteric artery, as the first step in the operation, ensures a practically bloodless field during the subsequent steps of the pelvic portion of it, and is therefore essential. This having been done a second ligature is placed on the vessels about an inch below the first in order to control venous bleeding from the distal part of the mesocolon when it is divided.

It is my practice, however, during the first stage to divide the lateral peritoneal leaf of the mesosigmoid, to extend this incision downward into the pelvis by the side of the rectum, then across the base of the bladder in the male or across the posterior aspect of the cervix in the female, and then upward on to the opposite side of the mesentery in order to display both ureters and to impart a greater degree of mobility to the sigmoid colon and rectum before isolating the main vascular pedicle and ligaturing it close to the aortic bifurcation with stout silk threaded on a curved aneurysm needle (figs. 282 and 283). This is a departure which does not find favour with Miles, who continues his description of the operation thus:

The pelvic mesocolon is divided completely immediately below the first ligature, and then the peritonæum, on either side of the line of origin of the mesocolon, is incised downward as far as the promontory of the sacrum. When



FIG. 282.—THE ABDOMINO-PERINEAL RESECTION OF THE RECTUM—MILES'S OPERATION.

The operation is commenced by mobilising the pelvic colon.

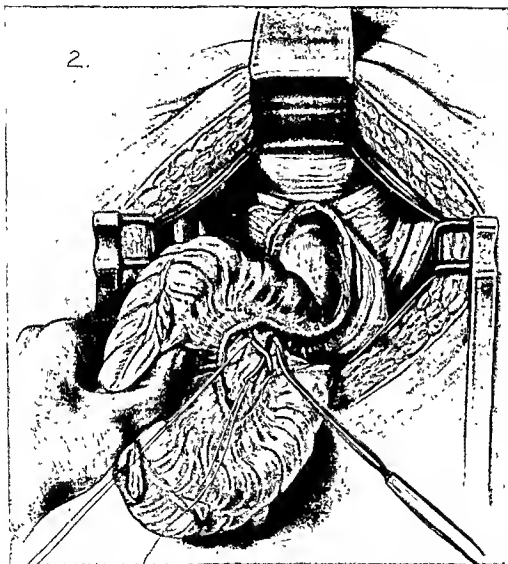


FIG. 283.—THE ABDOMINO-PERINEAL RESECTION OF THE RECTUM—MILES'S OPERATION.

The main vascular pedicle is being ligatured.

this is being done on the left side, the position of the left ureter should be carefully ascertained lest it be divided or otherwise injured. As soon as the peritoneum has been divided on both sides as far as the promontory, the cellular space, between the anterior surface of the sacrum and the terminal part of the pelvic mesocolon, comes into view.

By thrusting the fingers of the left hand into this space the terminal portion of the pelvic colon and the rectum can be stripped readily from the anterior surface of the sacrum as far as the sacro coccygeal articulation. At the latter point the fascia propria of the rectum is closely adherent to the periosteum of the lower border of the sacrum and cannot be stripped from it, thus indicating that the level of the articulation has been reached.

Occasionally one or two dense bands of connective tissue extend from the fascia propria to the sacrum (fig. 284). These should be divided with scissors rather than torn from their sacral attachments lest by so doing a presacral vein be lacerated and give rise to troublesome bleeding. The left hand is now introduced into the presacral space thus opened up and the rectum is pressed forwards and upwards in order to raise and render prominent the peritoneum lining the floor and the lateral walls of the pelvis. The pelvic peritoneum thus raised is divided forwards on either side parallel to the brim of the true pelvis as far as the base of the bladder, care being taken not to injure the ureters which often adhere closely to the peritoneum. These incisions in the peritoneum, along the brim of the true pelvis, are continued until they meet anteriorly behind the base of the bladder in the male or the upper part of the vagina in the female.

The separation of the anterior wall of the rectum from its connections is next proceeded with. In the male, a well-marked stratum of loose areolar connective tissue exists between the fascia propria of the rectum and the layer of recto-vesical fascia which binds the vesiculæ seminales to the base of the bladder. When this line of cleavage is found the separation of the rectum from the vesiculæ seminales and the base of the bladder is easily effected, but unless care be exercised the space containing the vesiculæ may be opened up, and then the dissection becomes extremely difficult, so that the vesiculæ or the vasa deferentia may be injured. It is important that the separation of the rectum anteriorly should extend as far as the upper border of the prostate gland.

As soon as the rectum has been freed from its connections both anteriorly and posteriorly down to the points indicated above, the lateral attachments of the rectum can be readily made out. These consist, on either side, of a broad band of dense connective tissue, varying in depth from two to three inches, which passes forwards and outwards from the lateral walls of the rectum towards the base of the bladder at the point where the ureters terminate. These bands, the lateral ligaments of the rectum, must be completely divided down to the upper surfaces of the levator ani muscles (fig. 285). The middle hæmorrhoidal artery, which passes in the substance of the ligament to its distribution, is always divided but is seldom of sufficient size to need a ligature.

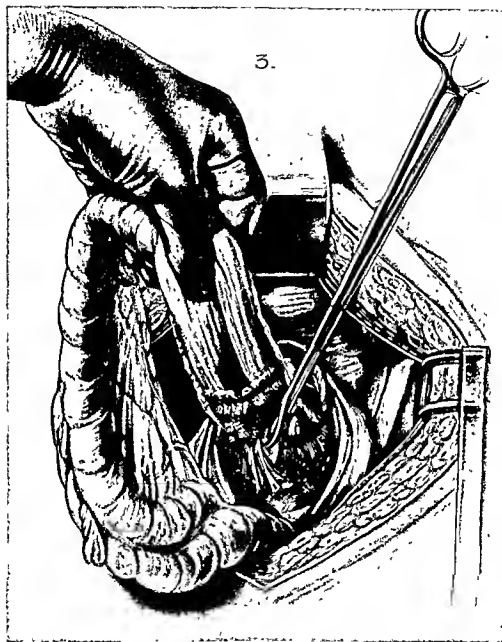


FIG. 284.—THE ABDOMINO-PERINEAL RESECTION OF THE RECTUM—MILES'S OPERATION.

The rectum is being freed from the sacrum.

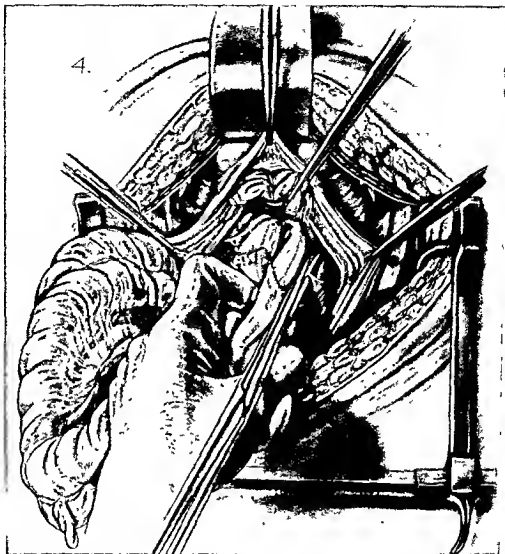


FIG. 285.—THE ABDOMINO-PERINEAL RESECTION OF THE RECTUM—MILES'S OPERATION.

Division of the lateral ligaments of the rectum.

The rectum having thus been freed from its connections anteriorly as far as the upper border of the prostate or the upper third of the posterior wall of the vagina, posteriorly down to the level of the sacrococcygeal joint, and laterally to the upper surface of the levator ani muscles, the pelvic colon is steadied and crushed with three de Martel clamps at the seat of election, which is a point situated approximately 3 inches from the end of the descending colon. The

middle clamp is removed and the crushed groove of bowel which remains between the proximal and distal clamps is slowly burned through with a cautery. The distal end of the pelvic colon embraced in the de Martel clamp is next pushed downward into the pre-sacral space until it rests at the level of the sacrococcygeal articulation where it can easily be reached when the perineal portion of the operation is being performed. The remainder of the distal part of the pelvic colon is now crowded down into the cavity of the pelvis and preparations are made for re-establishing the floor of the pelvis with mobilised peritoneum.

Miles has frequently stressed the fact that the large gap which remains in the pelvic peritoneum cannot be closed by dissecting up the peritoneum from the lateral walls of the pelvis. However much the peritoneum may be mobilised at the sides of the gap, the edges can only be approximated posteriorly in front of the promontory of the sacrum and sutured to the stump of the pelvic mesocolon. The large pear-shaped gap remaining after this has been done can be readily filled in, however, by dissecting up the peritoneum with the fingers from the base and from the lateral aspects of the bladder in the male and stretching it backward across the gap and suturing it there; or by dissecting up the innermost layers of the broad ligaments in the female and utilising them to fill up the space, as may be noted in figure 286.

It is imperative that the suture line in the new peritoneal floor should be intact and practically waterproof (fig. 287). When therefore the peritoneum is thin and likely to tear, an omental graft should be used to reinforce the suture line.

When the suturing is completed, the newly reconstructed pelvic floor will be seen to lie almost at the brim of the true pelvis, but in process of time this diaphragm is pushed and drawn downward into the depths of the pelvis.

The proximal end of the pelvic colon embraced in the de Martel clamp is now used for establishing a permanent colostomy. The best position for this is at a point situated $1\frac{1}{2}$ to 2 inches medial to the left anterior superior iliac spine along an imaginary line extending from that bony prominence to the umbilicus. A circle of skin $1\frac{1}{2}$ to 2 inches in diameter is excised, its centre being at a point at the junction of the outer and middle thirds of an imaginary line drawn

5.

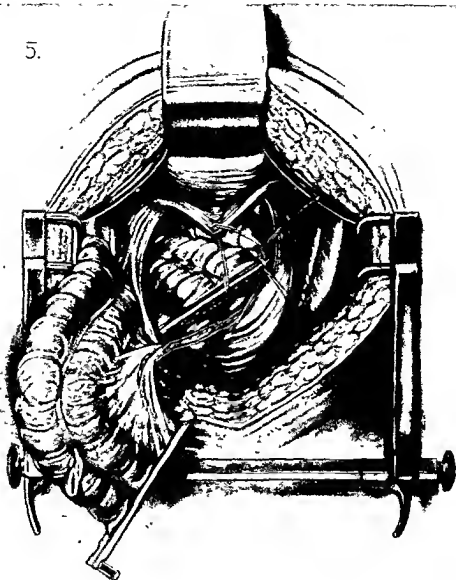


FIG. 286.—THE ABDOMINO-PERINEAL RESECTION OF THE RECTUM—MILES'S OPERATION.

Commencement of the reconstruction of the pelvic floor. Note the position of the silk suture.

from the anterior superior iliac spine to the umbilicus. The object of excising the circle of skin is to prevent subsequent stenosis of the stoma. The wound is deepened, the aponeurosis of the external oblique is divided to the extent of 1 to $1\frac{1}{2}$ inches, and the muscular

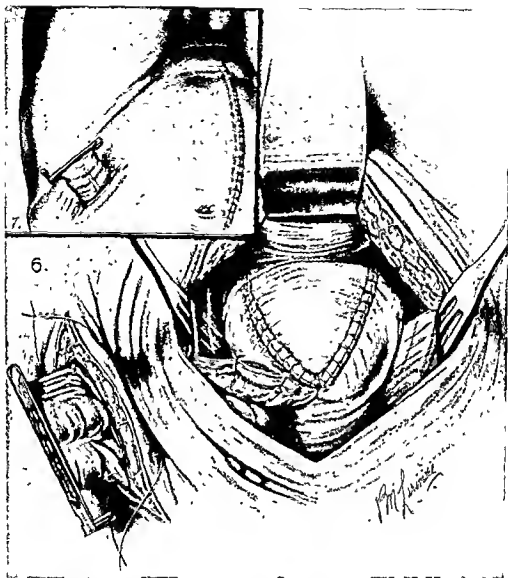


FIG. 287.—THE ABDOMINO-PERINEAL RESECTION OF THE RECTUM—MILES'S OPERATION.

The pelvic floor has been reconstructed and the lumbar gutter shut off with a few interrupted sutures. Note the method of anchoring the stump of colon in the small iliac wound.

fibres of the internal oblique and transversalis muscles are then separated in the direction of their fibres by blunt dissection.

An opening just large enough to admit a finger comfortably is now made in the transversalis fascia of the peritoneum, and through this

small opening the stump of the proximal end of the pelvic colon is drawn and fixed into position at the upper and lower angles of the wound by means of silk sutures (see fig. 287 [6 and 7]). It will be noted that these sutures do not pick up any portion of the bowel wall. The stump of colon projecting through the small stab wound should protrude at least $1\frac{1}{2}$ to 2 inches beyond the level of the skin. When the exteriorised limb of large bowel is unduly redundant it can quite easily be cut down to the desired length some two or three weeks following the operation when the abdominal wounds have firmly healed.

The abdominal portion of the operation is completed by inserting a few interrupted catgut sutures between the cut edge of the pelvic mesocolon and the lateral wall of the pelvis so as to shut off completely this potentially dangerous gutter; by removing the abdominal packs and swabs; and then by suturing the long paramedian incision, layer by layer, with No. 1 twenty-day chromic catgut.

Temporary dressings are applied to the wound, and the patient is turned over on to his right side and placed in Sims' position so that the perineal portion of the operation may be carried out.

The Perineal Portion of the Operation. In an uncomplicated case Miles usually completes the abdominal portion of the operation in forty-five minutes, and the perineal part in fifteen minutes. Here is his own account of the perineal portion of the operation:

The anus having been closed by means of a purse-string suture, a transverse incision about four inches in length is made at the level of the sacro-coccygeal articulation. From the centre of this a longitudinal cut is made in the inter-natal furrow, and carried down to a point one inch from the posterior margin of the anus. From the inferior extremity of this, incisions are carried to the right and to the left of the anus in the shape of a horseshoe, and the anterior extremities of these are joined by a transverse cut (fig. 288 [2]). It is important that the arms of the horseshoe should embrace as wide an area of perianal skin as possible, because the skin in this region is especially prone to develop recurrent growth. The gluteal skin flaps are then reflected and retracted out of the way, thus laying bare the coccyx.

The sacro-coccygeal joint is opened and the coccyx dissected out; the incisions surrounding the anus are then deepened so as to include as much as possible of the ischio-rectal fat. It is never necessary to remove a piece of the sacrum, as ample room is provided by removal of the coccyx alone. In fact, sufficient room for the completion of the operation can be obtained without even removing the coccyx; but I think it is best to remove it, because as the

coccygeus muscles must be removed, the bone would be left without any lateral attachments.

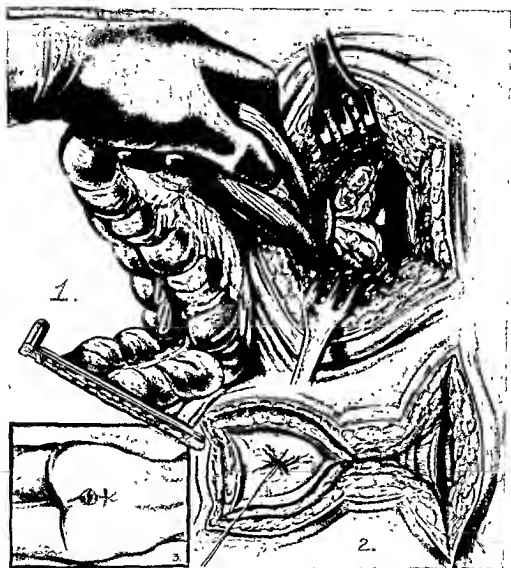


FIG. 288.—THE ABDOMINO-PERINEAL RESECTION OF THE RECTUM—MILES'S OPERATION.

The essential steps of the perineal portion of the operation are depicted.

A small transverse incision is made into the dense connective tissue immediately below the sacrum, where the attachment of the fascia propria recti can readily be detached from the ventral aspect of the lowermost piece of the sacrum. The index finger is then thrust into this, when, supposing that the separation of the rectum from the front of the sacrum has been carried down

to the level advocated above, it readily passes into the space containing the isolated bowel. A transverse incision is then made through the coccygeus muscle on either side, extending outwards as far as the great sacro-sciatic ligaments. Through the ample opening thus made the isolated bowel is drawn down to its full extent.

When the separation of the anterior connections of the rectum have been carried down to the prostate during the abdominal part of the operation, the base of the bladder and the vesiculæ seminales, with the vasa deferentia and the upper part of the prostate, come into view (this is clearly seen in figure 288 [1]). In the female, the upper half of the posterior vaginal wall can be plainly seen.

By making traction upon the bowel with the left hand the levatores ani are put on the stretch. If they do not come into view, it is because the lateral ligaments of the rectum have not been completely divided from above. In that case considerable difficulty may be experienced in delivering the loosened bowel through the perineal wound, and until the lateral ligaments have been completely severed the levatores cannot be divided. The levatores are now divided at their origin from the lateral wall of the pelvis, the pubo-prostatic fibres being detached from the prostate.

In those instances in which the growth is situated on the anterior wall of the ampulla of the rectum, I always make a practice of dissecting away the prostatic capsule as well lest invasion of it may have commenced.

All that now remains to be done is to dissect away the anterior wall of the anal canal from the tissues forming the central point of the perineum, great care being taken not to wound the membranous portion of the urethra in so doing. It is not necessary to introduce a sound into the bladder for the purpose of indicating the position of the urethra.

After the removal of the rectum and the isolated portion of the pelvic colon, usually about sixteen inches in length, a large cavity is left. This cavity is surrounded by bony structures behind and at the sides, and it is absurd to suppose that it can be sewn up so as to obtain healing by primary intention. The cavity must heal gradually by granulation, portions only of the skin incision being brought together by sutures.

I always pack the cavity with long strips of gauze, so as to afford support to the new pelvic floor formed only by peritoneum. It is not advisable to allow the gauze to be in direct contact with the walls of the cavity, because it becomes firmly adherent to them, and gives considerable pain and trouble to the patient when it is removed.

In one of my earlier cases, the peritoneum of the pelvic floor was torn when the gauze was removed, and a coil of small intestine became herniated through the opening. I always use a sheet of green protective, two feet square, for lining the cavity, and then pack the gauze into it, the subsequent removal of the gauze thus being rendered easy and painless.

Dressings and bandages are then adjusted, and the patient is turned upon his back so that the abdominal wounds may also be dressed. Before the patient leaves the table the de Martel clamp on the proximal end of the pelvic colon is removed, and the open end of the bowel is covered with green protective and a pad of gauze.

Treatment During the First Forty-eight Hours After Operation. The patient is transferred to his bed in the theatre, and if shock is severe the foot of the bed is raised on blocks as soon as he returns to the ward.

All the patients are immediately given a transfusion of one pint of blood. The blood is introduced into the internal saphenous vein in the leg or into a vein in the outer aspect of the arm, at the rate of about 20 drops per minute, and when this has been run through, a continuous saline-glucose solution is substituted. The continuous drip is maintained for forty-eight hours, during which time some 7 to 8 litres of fluid are administered. Fluid by mouth is withheld during this period in order to diminish the risk of acute dilatation of the stomach and post-operative ileus. If there is early evidence of ileus a duodenal tube should be passed and suction-siphonage carried out without delay.

Frequent mouth-washes are given and the patient is encouraged to suck acid drops and the like in order to keep up a steady flow of saliva. Omnopon, gr. 1/6, is injected as soon as the patient awakens from the anæsthetic. Further injections are ordered as required to allay restlessness and pain.

Aylett emphasises two important points in the nursing care:

(a) The patient should on no account be allowed to remain on his back for more than six hours; after this time he must be turned on his side. If this six hours be exceeded, even in patients with apparently normal arteries, there is a tendency for the perineal wound to become gangrenous and to slough around the sutured area.

(b) When the patients are lifted in bed they must be raised by arms placed behind the knees and round the chest, as the perineal wound is readily torn if any drag is placed on the upper part of the thighs or buttocks.

The question of attention to the bladder arises about eight to ten hours after operation. A distended bladder is a danger, as it may stretch or tear the newly-reconstructed peritoneal pelvic floor. Again,

the normal tone of the bladder is lost for some days if it is allowed to remain abnormally distended for any length of time. The patient is encouraged to pass water at the end of eight to ten hours; if he cannot do so, three subcutaneous injections of esmodil are given at intervals of twenty minutes. If there is no response after the third injection, the patient should be catheterised, and the bladder washed out with 1/10,000 oxycyanide of mercury solution. The catheterisation must be repeated every eight hours for the next two or three days, after which time it will be found that normal function is usually established.

In females it is safer to insert a self-retaining catheter before the operation and to keep it in situ for two to four days rather than to resort to repeated catheterisation with its attendant risks.

In the early post-operative period the patient is given inhalations of oxygen, and later on deep breathing exercises are instituted.

The Treatment After the First Forty-eight Hours. At the end of forty-eight hours the patient starts to take fluid nourishment by mouth. At first, sterile water in 2-oz. doses is given hourly for eight hours, and for the succeeding similar period 4-oz. drinks are allowed. At the end of this time the amount of water given is gradually increased, being varied with tea, barley water, glucose-lemonade and fresh fruit juices, until about the fourth day when a light non-residue nutritious diet is ordered.

The perineal wound is dressed for the first time seventy-two hours after the operation. After the packing has been removed, the cavity is gently irrigated with: (a) hydrogen peroxide (10 volumes) one pint, followed by (b) perchloride of mercury, 1/500 (one pint), followed by (c) two pints of normal saline solution. Irrigation with these solutions is carried out twice daily during the first week, after which period a solution of iodine or dettol (two drachms to the pint) is substituted.

The colostomy usually works spontaneously about the third or fourth post-operative day. On the morning of the fifth day a simple enema is given through the colostomy, and on the following day a saline purgative is prescribed. The colostomy wash-out is repeated daily until the patient is discharged from hospital. At the end of a week, the excess of bowel forming the colostomy is cut down. Digital dilatation of the stoma is performed daily after the twelfth post-

operative day, until the tendency to contract during the healing process has ceased.

The patient is allowed to get out of bed for the first time on the eighteenth day for twenty to thirty minutes. By this time the perineal cavity is small and easily dressed. Any tendency to epithelialisation of the cavity by ingrowth from the surface is controlled with a silver-nitrate stick, and in seven to eight weeks the wound should be healed. Unless the patient is instructed on his discharge to refrain from sitting in the plumb position equally on both buttocks, the perineal wound while still delicate will often split open and bleed freely. A suitable colostomy belt with a shallow cup is ordered.

4. Two-Stage Abdomino-Perineal Resection of the Rectum—Lahey's Method. This is the best of the many two-stage modifications of Miles's operation. It was first described by Lahey in 1930 (*Surg., Gynec. & Obst.*, 51:692, 1930) and modified by Cattell four years later (*New England J. Med.*, 210:403, 1934). A full account of the indications, the advantages, the disadvantages, the operative technique and the results of this two-stage method of resection of the rectum is given by Lahey and Cattell in the *American Journal of Surgery* (27:201, 1935), and by Cattell in *The Surgical Clinics of North America* (19:657, 1939).

It has always seemed strange to me that this carefully thought out and successful operation should have met with such scant recognition in this country. The following are some of the criticisms which I have heard levelled against this procedure:

(a) The malignant lesion in the rectum is left in situ for at least two weeks longer on account of the interval between the two stages of the operation. I do not consider this to be an important delay in view of the long-standing history which obtains in most of these cases.

(b) It does not divide the operation into two equal parts, since the second stage consists of an abdominal and perineal resection, making it necessary to open the abdomen during both the first and second stages. It is true that the first stage is a more extensive operation than that which follows the performance of an ordinary loop colostomy.

(c) Adhesions as a result of the first-stage operation may complicate the second-stage resection. There is no doubt that certain techni-

cal difficulties arise when abdominal adhesions are encountered during the second laparotomy; but these difficulties have now been largely circumvented by means of the technique of the first stage of the operation.

(d) There is the additional danger entailed in submitting the patients to two anæsthetics, and to two major operations with all the attendant risks. These risks are certainly not so great as those associated with a one-stage operation improperly applied, and I do not regard this as an important disadvantage.

The advantages of this two-stage operation may be outlined as follows:

(a) *General*: (i) the patient's general condition can be considerably improved between the stages; (ii) a normally functioning colostomy is established before the radical part of the operation is performed; (iii) the operation can be carried out in patients suffering from chronic or even sub-acute large-bowel obstruction; (iv) a peritoneal immunity may conceivably result from handling and dividing the bowel at the first stage, as is suggested by the low incidence of peritonitis following the second operation; (v) there is less operative shock; (vi) the operation is no less limited in extent than Miles's procedure; and (vii) it can be performed more often in complicated cases as well as in elderly and poor-risk subjects.

(b) *Local*: (i) cleansing of the tumour-bearing segment of bowel by irrigations can be carried out simply, expeditiously and without danger; (ii) this cleansing and attention to the distal segment of bowel diminishes œdema and infection and often leads to a considerable reduction in the size of the malignant mass, thus rendering mobilisation and resection of the rectum easier; (iii) viability of the segment to be resected is maintained between the stages.

I have practised this operation on a number of occasions with a low operative death-rate, and it is my firm conviction that the advantages of this two-stage abdomino-perineal resection far outweigh the disadvantages. It is, of course, trite to state that no one type of operation should be applied to all patients with cancer of the rectum and rectosigmoidal junction.

At the Lahey Clinic the following range of operations is utilised for rectal cancer:

(a) One-stage abdomino-perineal resection (Miles). This is per-

formed in approximately 20 per cent of the cases and includes the good-risk patients and particularly those under 55 years of age.

(b) Two-stage abdomino-perineal resection (Lahey). This is employed in 60 per cent of the cases.

(c) Anterior or abdominal resection with permanent colostomy (Hartmann). This operation is carried out in only 5 per cent of the cases. There are a number of elderly obese poor-risk cases who will not successfully withstand an abdomino-perineal resection in either one or two stages. For such patients with a high rectosigmoidal lesion, and more especially where the growth is situated above the peritoneal reflection, Hartmann's method would appear to be particularly suitable.

(d) Perineal excision with permanent colostomy (Lockhart-Mumery). This method is used in 15 per cent of the cases and is eminently applicable to the low rectal growths which occur in aged or infirm patients.

The utilisation of these four operations for resectable malignant cancers of the rectum has permitted a gradual extension of operability, so that at present few patients are found with this dread disease who cannot entertain some hope of benefit by some one type of resection.

What are the results of this two-stage method of excising the rectum? Cattell puts the case as follows:

We have utilised this two-stage abdomino-perineal resection in over 175 cases of carcinoma of the rectum. We feel that its value has been clearly demonstrated. It has been one of the important factors in increasing our operability rate from 55% in 1927 to 89% in 1937. The operative-mortality for this operation, even when adapted to poor-risk patients and those with extensive malignancy, has remained between 10 and 13%. Furthermore, it has given as good results so far as recurrence goes as the one-stage abdomino-perineal resection.*

First Stage of the Lahey Method. A spinal anæsthetic is given, the abdomen is prepared in the usual manner, and the patient is placed in a slight Trendelenburg position. A vertical left para-umbilical incision, 4 inches long, is made at the junction of the middle and outer thirds of the rectus muscle, extending equally above and below the umbilicus. All the layers of the abdominal wall are divided in

* Cattell, *Surg. Clin. N. Am.*, 19 657, 1939. Courtesy of W. B. Saunders Co

line with this incision, which possesses these advantages: If the case proves inoperable, a simple loop colostomy can be performed without difficulty, as the sigmoid colon is ready to hand; if a Hartmann or Miles operation is indicated, the incision can be extended downward to the pubis; if the two-stage abdomino-perineal resection is deemed advisable, it offers the best exposure for the first-stage procedure, since this is confined to the sigmoid loop; it allows of a more satisfactory closure of the lateral gutter under direct vision; and finally it permits of the opening of the abdomen at the second-stage operation at a point not complicated by a previous incision.

Following the abdominal exploration, the sigmoid colon is picked up and the loops of small intestine are packed out of the way with large gauze swabs. The avascular reflection of the parietal peritoneum on to the sigmoid colon laterally is put on the stretch and divided with scissors to the level of the iliac vessels below and then continued upward along the outer border of the descending colon. This allows of a most satisfactory mobilisation of the pelvic colon which can now be lifted boldly forward and pulled across toward the middle line. The sigmoidal branches of the inferior mesenteric artery and those of the left colic artery can be seen, or at least felt, and the site for the division of the sigmoid selected. This site for the transection is based on the distribution of the blood vessels as well as on the mobility of the colon both proximal and distal to this point.

The peritoneum over the mesosigmoid is then incised on each side so that the anastomotic vessels between the sigmoidal and left colic arteries can be isolated, clipped, divided, and ligatured individually. The fatty mesosigmoid is divided vertically down to the superior hæmorrhoidal blood vessels, which must in all cases be most scrupulously preserved as they are the main source of nourishment to the distal segment of bowel (fig. 289). It must be emphasised here that the preservation of these vessels is the most important part of the first-stage operation.

The medial portion of the wound is elevated and the peritoneal reflection over the bladder is visualised before making a small stab wound in the middle line, some two finger-breadths above the symphysis pubis. Through this stab wound a large curved hæmostat is passed to grasp the sigmoid colon at a point distal to the line selected for the transection of the bowel.

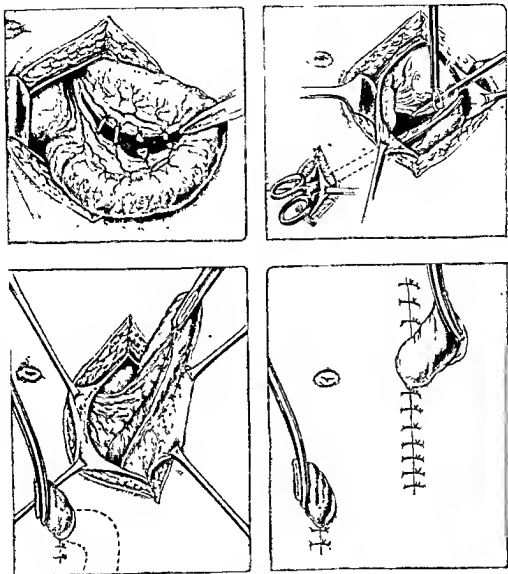


FIG. 289.—THE ABDOMINO-PERINEAL RESECTION OF THE RECTUM IN TWO STAGES
—LAHEY'S METHOD.

The more important steps in the first stage are illustrated. (After Lahey and Cattell.)

A second clamp is then placed through the original wound on the proximal side and hard up against the curved clamp, and the bowel is divided between the clamps with a cautery (see fig. 289). Any redundancy of the bowel beyond either clamp is slowly burned away to avoid contamination.

The peritoneum of the suprapubic stab wound and of the medial side of the main incision is now firmly retracted and the curved clamp holding the end of the distal segment of bowel is brought out on to the surface of the abdomen without its coming in contact with the peritoneum. The forceps grasping the edges of the peritoneum or stab wound are released, and the skin is closed loosely about the implanted distal segment. This completes the suprapubic implantation, and the wound is sealed off with cellophane squares and gauze swabs.

The proximal limb of colon embraced by the clamp is now drawn vertically upward and put slightly on the stretch so that the lateral lumbar gutter which exists between the external aspect of the bowel and the parietal peritoneum can be closed by suturing the parietal peritoneum to the peritoneum along the border of the sigmoid. It is best to use interrupted catgut sutures and to see that this approximation is carried out in a vertical direction to this segment of bowel (see fig. 289).

At this stage the cut edge of the mesosigmoid will be seen to be stretched in a V with the apex in the region of the superior hæmorrhoidal vessels and extending upward and outward to the proximal and distal loops. The free edge of the omentum is picked up and stitched with interrupted sutures to the upper side of the denuded mesocolon. The first suture should be placed close to the superior hæmorrhoidal blood vessels, and after anchoring the omentum to the distal cut margin of the mesosigmoid the proximal cut margin of this structure is joined to the omentum. The final sutures include small portions of omentum, mesosigmoid and parietal peritoneum, at the points of emergence of the two limbs of bowel, so that no gap remains through which a portion of intestine may become strangulated. It will facilitate matters at the second operation if the free edge of the omentum is tacked down to the medial border of the meso-colic peritoneum, as illustrated in figure 289. The original wound is now closed in layers about the proximal limb, tabs of fat or appendices epiploicæ being anchored at each side of the peritoneal closure.

Interval Between the Stages. If there is evidence of obstruction, the clamp on the proximal end of the bowel is removed, and a catheter is immediately inserted. If on the other hand there is no evidence of gaseous distension, the clamp may with advantage be left

in place for forty-eight hours. The distal clamp is removed on the fifth post-operative day, and irrigations are commenced. The distal segment of bowel is thoroughly washed out two or three times a day with normal saline solution or some weak antiseptic solution until the time of the second-stage operation. A thorough flushing of the excluded segment can be achieved by inserting a large catheter into the suprapubic colostomy and by placing a rectal tube or proctoscope in the anus to provide an exit for the fluid which is introduced from above.

In the presence of obstructive lesions of the rectosigmoidal region or where the rectum is filled with a large fleshy mass of growth, it may be necessary to wash out the gut both from above and from below; but after a few days it is usually possible to carry out the irrigations satisfactorily in a through-and-through manner. All the pent-up faecal matter and all the daily accumulations of blood, mucus and pus can be washed away so that the distal segment can be kept in as clean and healthy a condition as possible.

The permanent colostomy works spontaneously on the third or fourth day after operation, and after this time occasional enemata may be required. The average length of time between the stages is fifteen days, but the second stage can be delayed even longer if the patient is not responding satisfactorily to treatment, as the lower loop is viable.

Second Stage of the Lahey Method. The bladder is catheterised, continuous glucose-saline solution is run into a vein, a spinal anæsthetic is administered, and after suturing the suprapubic stoma the functioning colostomy is sealed off with adhesive dressings. The abdomen is lavishly painted with alcohol and fresh sterile towels are applied before making a midline incision, which commences just below the umbilicus. The abdomen is opened and the incision is extended downward to enclose the implanted loop, which can be speedily disconnected, care being taken during the dissection to avoid any injury to the bladder (fig. 290). The omentum, which will be found firmly adherent to the V-shaped mesosigmoid, is freed by blunt dissection from the distal loop right down to the point of its attachment over the superior hæmorrhoidal blood vessels. The firm fixation of the omentum to the proximal loop is left undisturbed throughout the operation.

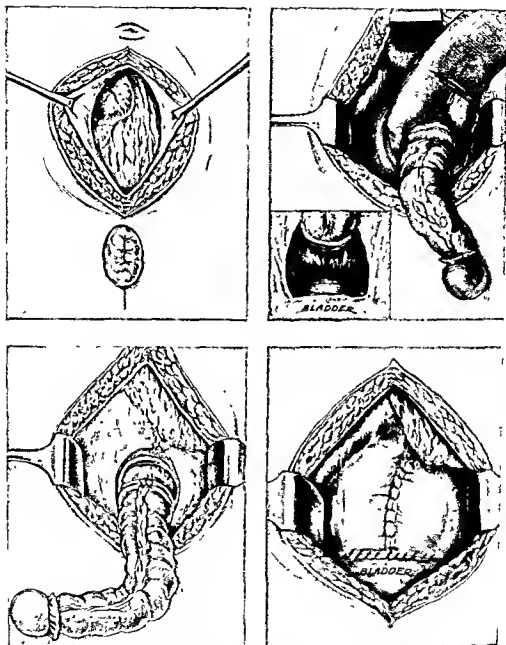


FIG 290.—THE ABDOMINO-PERINEAL RESECTION OF THE RECTUM IN TWO STAGES
—LAHEY'S METHOD.

The more important steps of the abdominal portion of the second stage of this method are shown. (After Lahey and Cantell.)

As soon as the lower limb of bowel has been completely liberated, a thin sheet of rubber tissue is tied over it in order to avoid soiling during the abdominal dissection. From this point onward the operation is in many respects similar to the remainder of the one-stage abdomino-perineal resections already described, except that the main blood vessels are ligatured below the origin of the last sigmoidal artery.

The superior hæmorrhoidal blood vessels are lifted above the sacral promontory and isolated, and both ureters are identified before the vascular pedicle is tied off in two places and divided between these ligatures. After division of these blood vessels, an incision is made on each side of the peritoneum of the lateral pelvic wall, immediately medial to the course of the ureters. These incisions are produced downward and meet in the middle line. In the male, the anterior portions of these incisions cut across on a level with the base of the bladder; in the female, the incision crosses the utero-sacral ligaments at the level of the cervix, at which point the vaginal plexus of veins is encountered.

In the posterior dissection the fingers steal in behind the rectum into the pre-sacral space and lift the rectum bodily away from its attachments in this region right down to the sacro coccygeal articulation (see fig. 290). The pre-sacral nerves will now be exposed, and in cases of doubtful operability it is wiser to divide them. The lateral ligaments of the rectum are next divided by a combination of sharp and blunt dissection, down to the levator ani muscles. In the male, the anterior dissection will not be complete until the lower posterior wall of the bladder comes freely into view, until the seminal vesicles are displayed, and until the upper half of the prostate is clearly visible (see fig. 290). In the female, the anterior dissection frees the rectum from the cervix and from the upper third of the posterior wall of the vagina. If the growth has extended and implicated the cervix, uterus or broad ligaments, pan-hysterectomy should be carried out at this point, leaving the uterus and its appendages attached to the rectal segment. The entire group of structures can be reduced into the pelvis ready for delivery through the wound which is later made in the perineum.

The lower segment of bowel is now freed as completely as possible by the anterior, the lateral, and the posterior dissection, and this

segment is now crammed down into the pre-sacral space before closing the wide gap in the floor of the pelvis with mobilised peritoneal flaps. Probably the most important step in the second stage of the operation consists in the freeing up of these pelvic peritoneal flaps so that the new diaphragm can be reconstructed without any degree of tension. These flaps are freed by a combination of sharp and blunt dissection, well beyond the ureters, and by lifting the peritoneum off the posterior and lateral walls of the bladder with the fingers.

The now mobilised peritoneal flaps are sutured together, and if any weak spot remains in the suture line this is reinforced with the free margin of omentum which was previously detached from the distal portion of the divided mesosigmoid.

In female patients the uterus may sometimes be utilised to reinforce this suture line, as shown in figure 291.

The incision is closed in layers without drainage of the peritoneal cavity, although a small suprapubic drain is led down to the sutured parietal peritoneum, and at times another drain is placed in the upper angle of the incision.

The Perineal Portion of the Operation. The perineal part of the operation is performed with the patient lying on his left side in a modified Sims position. The anus is closed with two purse-string sutures of silk, and a triangular incision, with the base toward the genitals, is made in closing the anus and the internatal fold (see fig. 291). This incision is deepened through the fatty tissues and the ischio-rectal fascia, down to the levator ani muscles. The coccyx is not removed. A transverse incision is now made across the unyielding pelvic fascia, just in front of the coccyx, and the roomy pre-sacral space is entered.

The entire mobilised bowel segment is now drawn through the wound and a finger is introduced under the levator ani muscle on each side, and these muscles are divided as far forward as possible. There may be a brisk hæmorrhage from the middle or inferior hæmorrhoidal blood vessels; if so, these must be secured and ligatured with plain catgut. The remaining attachments of the levator ani and transverse perineal muscles are quickly divided (see fig. 291). In female patients, the dissection will be facilitated by introducing a finger into the vagina while the rectum is being liberated anteriorly.

The large pelvic space is now inspected, and any visible bleeding points are secured and ligatured off. A small cigarette drain is placed into the cavity and the wound is closed about it, leaving the drain protruding through the *midline of the incision* (see fig. 291).

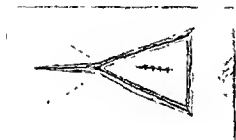
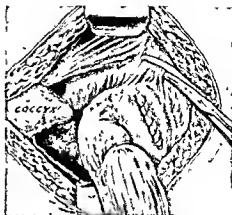


FIG. 291.—THE ABDOMINO PERINEAL RESECTION OF THE RECTUM IN TWO STAGES—LAHEY'S METHOD.

The two upper left-hand figures show the methods of reconstructing the pelvic floor. The remaining illustrations concern the perineal portion of the operation. (After Lahey and Catell)

Post-Operative Treatment. As soon as the patient has been returned to bed, a transfusion of 500 cc. of blood is routinely given, and after this glucose-saline is run into a vein at a slow drip. An inlying catheter is placed in the bladder for constant drainage in order to be certain that there is no bladder distension which might produce an undesirable amount of tension on the freshly sutured pelvic floor.

The drains in the abdominal wound are removed on the fourth day, and at the same time the cigarette drain is withdrawn from the perineal wound. The latter is replaced by a strip of corrugated rubber tissue.

Starting on the sixth or seventh day after operation, the perineal wound is irrigated three times a day with normal saline solution. The perineal wound continues to drain a little serum after the patient leaves hospital. He should be instructed in the management of the colostomy and be given printed details.

5. The One-Stage Perineo-Abdominal Excision—Gabriel's Operation. This operation is based on the two-stage perineo-abdominal excision described by Grey-Turner in 1920 (*Brit. M. J.*, 2:734, 1920). Most comprehensive details of this method have been given by Gabriel in his book, *Rectal Surgery* (2nd ed., 1937) and in the *Royal Northern Operative Surgery* (p. 244, 1939).

The important features of the perineo-abdominal excision are:

(a) The perineal portion of the operation is performed first, the mobilised rectum then being removed through the abdominal cavity.

(b) The pelvis being empty, the reconstruction of the pelvic floor from above is rendered a relatively simple affair.

(c) The large bowel is removed up to the iliac colon, thereby ensuring a wide resection of gut.

(d) The division of the colon is carried out extraperitoneally so that the risk of peritonitis is almost entirely eliminated.

(e) This operation is attended by less shock than is the abdomino-perineal resection, and it can be carried out with a good expectation of success even in the aged and obese.

The operation is divided into four parts:

The Preliminary Abdominal Exploration. The patient is placed in a slight Trendelenburg position and the exploration is carried out through a long right sub-umbilical paramedian incision. If no bar to excision is found, the incision is temporarily closed with three or four through-and-through sutures of strong silk which are tied over a broad gauze dressing laid on the wound. This is then covered over with a sterile towel which is kept in position with wide strips of elastoplast.

The Perineal Dissection. This part of the operation is almost identical with that of the Lockhart-Mummery perineal excision (see page

1282) until the stage is reached when the pedicle containing the superior hæmorrhoidal blood vessels is about to be transfixed and ligatured. In the perineo-abdominal operation the vascular supply of the rectum and sigmoid colon is left intact until the next stage. The rectum is freed anteriorly, laterally and posteriorly, the peritoneal pouch is widely opened up, and the mobilised bowel, after being wrapped in a protective layer of gauze and encased in a sterile glove, is pushed upward into the pelvis in preparation for the abdominal stage.

The posterior third of the perineal wound is closed with a series of interrupted sutures and the wound is covered with a large dry pack and sterile towel, this being kept in place with adhesive strapping.

The Abdominal Stage. The patient is again turned on to his back and placed in the Trendelenburg position, the abdominal wound is re-opened, and the rectum enclosed in the rubber glove is picked up and drawn to its fullest extent through the widely retracted incision (fig. 292). The lateral incisions in the peritoneum on each side of the pelvic mesocolon are carried upward to display the inferior mesenteric artery and to ensure that there will be a wide removal of mesentery and colon. The inferior mesenteric artery is defined and ligatured with silk between the first and second or between the second and third sigmoid branches. A second ligature is applied about one inch below the first, and the pedicle is then cut across with scissors. After closing off the lateral lumbar space on the outer side of the iliac colon with a series of interrupted catgut sutures, an ample left iliac muscle-splitting incision is made, and through this the long segment of rectum and pelvic colon is withdrawn on to the surface of the abdominal wall. After mobilising the pelvic peritoneum, the oval gap in the pelvic floor is closed with a continuous Cushing suture of doubled No. 0 twenty-day chronic catgut. The free edge of omentum is drawn downward and sutured to the new pelvic diaphragm, after which the abdominal incision is closed in layers in the usual manner.

The left iliac incision is loosely approximated about the emerging colon, but the bowel is not sutured in position. It is better to pick up the free edge of the mesocolon and to stitch this to the parietal peri-

toneum, and on the opposite side of the bowel to anchor an appendix epiploica to the upper margin of the wound.



FIG. 292.—THE ONE-STAGE PERINEO-ABDOMINAL OPERATION—GABRIEL'S METHOD.

The small incision is now sealed off with waterproof sheets, de Martel clamps are applied to the colon, and after removing the middle clamp the gut is cut through with a cautery. The protruding stump of bowel is packed around with gauze, and the incisions are

finally dressed before attending to the toilet of the perineal wound.

The Toilet of the Perineal Wound. The patient remains on his back, his legs being held up vertically, and after swabbing the wound clean it is packed and sutured. Gabriel uses a thin yellow rubber anæsthetic bag, 10 inches in diameter, which after being sterilised is passed into the perineal wound and packed in with one or two lengths of folded gauze.

COMMENT. The main objection to this method is that it necessitates turning the patient over into a new position twice during the performance of the operation. This is not only a waste of time, but it undoubtedly produces a degree of shock and some disturbance of the circulation. During recent years this difficulty has been overcome by placing the patient in a Trendelenburg-lithotomy position by means of special thigh pieces attached to the table. This enables the surgeon to perform the abdominal portion of the operation while the assistant carries out the perineal part. This position saves time and with two surgeons working simultaneously the whole operation can be completed in forty to forty-five minutes. A full description of this technique was given by Lloyd-Davies in the *Lancet* (2, 1939)

CONSERVATIVE RESECTION OF THE RECTUM WITH PRESERVATION OF THE ANAL SPHINCTERS

In a proportion of carefully selected early cases of rectal cancer or of growths of the rectosigmoidal region, the surgeon may decide to perform a conservative resection of the rectum which preserves the sphincter muscles and anal canal.

The method of performing a conservative abdominal segmental resection with sutured anastomosis for growths of the distal third of the sigmoid colon and of the rectosigmoidal junction is described and illustrated on pages 1327 and 1330.

A brief account will now be given of the conservative perineal resection and of the conservative combined abdomino-anal operation.

1. Perineal Resection of the Rectum with Conservation of the Anal Sphincter Muscles—Pauchet's Method. The most ingenious method is that of Pauchet (*Pratique chir.*, 4:219, 1936). The figures here illustrated have been adapted from the drawings of that accomplished artist Dupret (figs. 293, 294 and 295).

Indications for the use of this operation are as follows:

(a) There is a small carcinoma situated in the ampulla of the rectum; it is of the early superficial type; it is judged to be of the

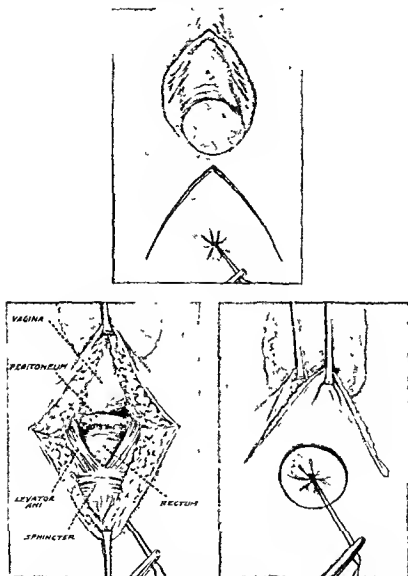


FIG. 293.—PERINEAL RESECTION OF THE RECTUM WITH CONSERVATION OF THE ANAL SPHINCTER MUSCLES—PAUCHET'S METHOD. (After Dupret.)

A group (Dukes); sigmoidoscopy has excluded the presence of a second carcinoma at a higher level or of associated adenomata, and treatment by diathermy is for one reason or another deemed inadvisable or, if employed, has failed to bring about a speedy cure.

(b) A large sessile innocent growth (confirmed by biopsy) occupies a wide area of the ampulla. Bleeding is profuse and uncontrollable;

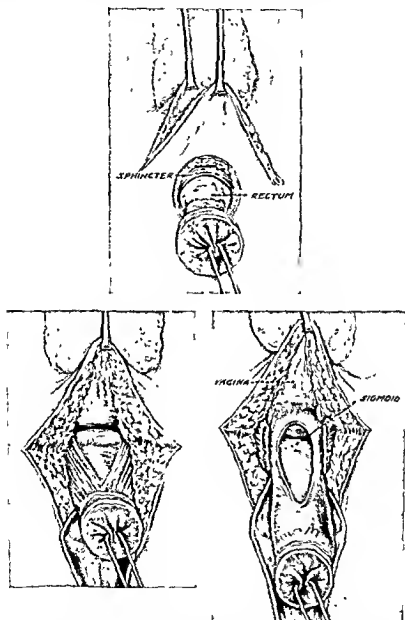


FIG. 294.—PERINEAL RESECTION OF THE RECTUM WITH CONSERVATION OF THE ANAL SPHINCTER MUSCLES—PAUCHET'S METHOD. (After Dupret.)

and repeated treatments with the coagulating diathermy current have proved unsuccessful.

(c) A non-malignant stricture of the rectum is present; proctotomy

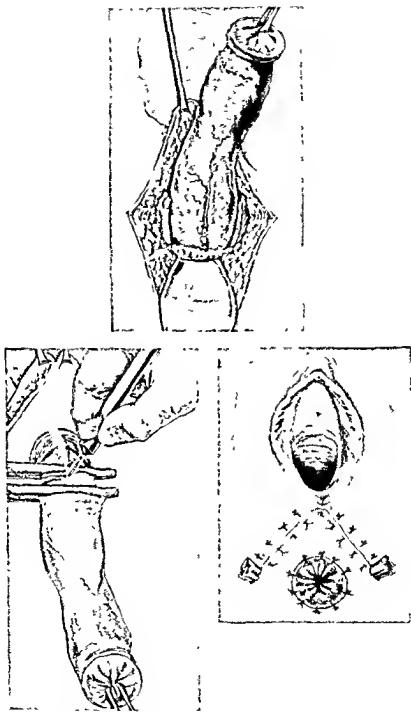


FIG. 295 —PERINEAL RESECTION OF THE RECTUM WITH CONSERVATION OF THE ANAL SPHINCTER MUSCLES—PALCHET'S METHOD. (After Dupret.)

and dilatations have failed to overcome the obstruction; the patient refuses the benefits of a temporary colostomy; and the general health is rapidly deteriorating.

Operative Technique. We will assume that the operation is being performed upon a female patient. The vagina is packed with gauze, the bladder is emptied, the patient is placed in the lithotomy position with a sandbag under the buttocks, the anus is closed with a purse-string suture and an inverted V-shaped incision is made as shown in figure 293. The incision is deepened and the skin at the apex of the inverted V is firmly drawn downward over the sutured anus. The wound is now widely retracted and an anterior dissection is carried out with the object of liberating the posterior wall of the vagina from the external sphincter muscle bundle.

Figure 293 represents a further stage in this difficult dissection. A small circular incision is next made around the anus, and this is deepened until the subcutaneous portion of the external sphincter muscle is clearly displayed. The anal canal is freed from its muscular tunnel until the lowest portion of the rectum can be drawn through the circular wound. The button of peri-anal skin, the attenuated anal cuff and the mobilised lower inch or so of the rectum are then pushed through the circular opening in the skin into the space above. The levator ani muscles are now divided close to the bowel; the peritoneal pouch is incised to display the sigmoid colon, and after dividing the lateral and posterior fascial attachments of the rectum the superior hæmorrhoidal vessels are put on the stretch, isolated, ligatured and divided as high up as possible.

The long mobile segment of lower bowel is next drawn through the muscular sphincteric canal, the opening in the peritoneum is closed around the emerging sigmoid loop, and the exteriorised large gut is clamped in two places about $1\frac{1}{2}$ to 2 inches from the skin margin and then transected with a cautery.

The proximal clamp is removed, the cut margin of the sigmoid colon is sutured to the circular skin incision, and the edges of the V wound are approximated with a series of interrupted vertical mattress stitches.

2. The Combined Abdomino-Anal Operation with Preservation of the Anal Canal and Sphincters. This is a combination of the Aldrich-Blake operation and of the Hochenegg telescopic method and can only be performed when:

(a) The tumour is situated in the rectosigmoidal region or lower third of the pelvic colon.

(b) When the malignant lesion is at an early stage in its development, *i.e.*, it is small, there are no palpable or visible evidences of extra-mural spread.

(c) The patient is of the slim type.

The immediate success or failure of this conservative procedure depends largely upon the efficiency and length of the sigmoidal arteries and upon the possibility of bringing down the mobilised pelvic colon to the anus without any degree of tension.

The operation is performed as follows: The abdominal and pelvic cavities are explored through a median sub-umbilical incision, and if the surgeon elects to carry out this operation the first step will consist in defunctioning the distal colon by fashioning a Devine colostomy in the right epigastric region. The sub-umbilical incision is then closed without drainage.

After an interval of two or three weeks, the combined conservative resection is carried out under spinal anaesthesia. The patient is placed in a combined Trendelenburg-lithotomy position and two surgeons work simultaneously, one performing the perineal dissection and the other the abdominal mobilisation. This method saves time and diminishes shock. The abdomen is opened at the second operation through a long left transrectus incision, a self-retaining retractor keeps the margins of the wound widely apart, the pelvic colon is mobilised and two strong ligatures are tied around the inferior mesenteric artery between the first and second sigmoidal branches—the seat of election, and the vascular pedicle is divided with scissors between the ligatures. The mobilised loop of gut is now drawn firmly upward, put on the stretch, and its blood supply carefully scrutinised. If the liberated colic segment appears to be well nourished with blood, it is pulled downward into the perineal wound by the surgeon working below, in order to empty the pelvis. The pelvic floor is reconstructed by bringing together the margins of the peritoneal leaves and stitching them around the now straightened pelvic colon. The abdominal incision is then closed in the usual manner without drainage.

Meanwhile the surgeon who has been conducting the perineal part of the operation has made a —< incision which spares the anus

and surrounding sphincteric muscle bundle, has removed the coccyx, divided the posterior portions of the levator ani muscles on each side, freed the rectum anteriorly, laterally and posteriorly, and has opened the peritoneal pouch in front and carried the incisions as high as possible, as in the perineo-abdominal excision.

The proximal one or two inches of the rectum, *i.e.*, the portion of rectum nearest to the anal canal, the anal canal itself and the sphincter muscles are carefully protected from injury during the perineal dissection. The mobilised pelvic colon and rectum are drawn to their fullest extent through the perineal wound, the rectum is cleared down to within 1 to 2 inches of the upper end of the anal canal, and de Martel clamps are applied to the bowel, as shown in figure 296. The centre clamp is removed and the rectum is burned through with a cautery between the two remaining clamps. The anus and anal canal are now swabbed with a 2 per cent aqueous solution of mercurochrome, the sphincter muscles are stretched until 3 or 4 fingers can be introduced, the lower clamp is removed and the cut end of the rectum is opened up, painted with spirit and its cut margins are held widely apart with Allis forceps.

The upper clamp affixed to the rectum is picked up and this is passed through the dilated anal canal. The clamp, as it emerges from the anus, is seized and the whole recto-colic segment is fully drawn through the anal canal, as depicted in figure 296.

The perineal wound is now closed with a series of interrupted vertical mattress sutures of silk, leaving sufficient room for the emergence of a small cigarette drain which is inserted into the pre-sacral space. The de Martel triple clamp is next applied to the exteriorised colon, 2 inches or so from the anal margin, and after removing the middle blade the crushed area of bowel wall is cut through with a cautery. The proximal blade is left in position and surrounded with gauze dressings. This latter blade works loose about five or six days later, after which time the protruding stump of colon slowly retracts into the anal canal where it eventually becomes adherent.

As soon as the perineal wound has healed and digital examination reveals a smooth junction without any evidence of stricture formation in the anal canal, the disconnecting anastomosis which was made in the transverse colon is closed and the intestinal continuity is once again restored.

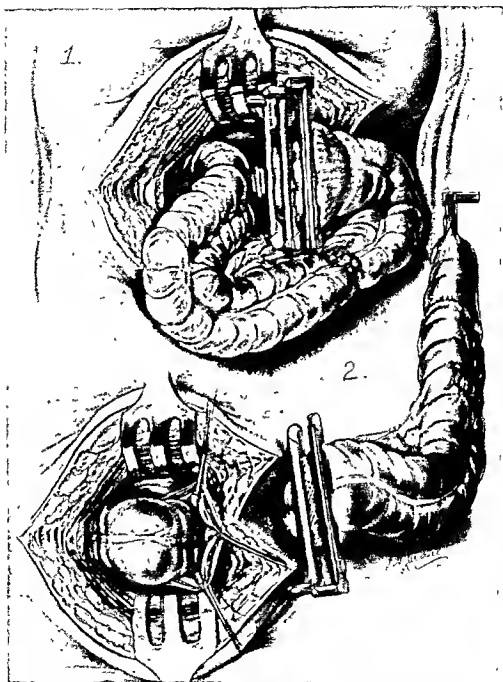


FIG. 296.—THE COMBINED ABDOMINO-PERINEAL OPERATION WITH PRESERVATION OF THE ANAL CAVAL AND SPHINCTER MUSCLES.

COLOSTOMY FOR INOPERABLE RECTAL CANCERS

A permanent simple loop colostomy will be required in the majority of patients who have inoperable growths in the rectum or distal colon. This useful operation avoids or relieves intestinal obstruction, diminishes pain, allows the patient to take a generous diet, improves the general condition, prolongs life by a few valuable months, and enables the rectum to be washed out thoroughly through the lower colostomy stoma. A colostomy should, however, not be performed in cases of rectal cancer in which on abdominal exploration the abdomen is found to be filled with ascitic fluid as the result of widespread metastatic implants in the peritoneum and omenta.

There are many types of colostomy. *e.g.*, loop, double-barrelled, Devine, etc., the opening usually being made in the transverse colon or in the sigmoid flexure.

In cases of irremovable rectal cancer the site chosen for the colostomy will often depend upon the position of the exploratory incision and upon the fixation or mobility of the pelvic colon. Thus, if the mesosigmoid is abnormally short and if, even after mobilisation of the colon, the loosened loop of bowel proves difficult to withdraw through the wound, it is wiser to close the incision and to carry out a transverse colostomy.

I usually explore the abdomen through a right sub-umbilical paramedian or midline incision, and in those cases where the rectal growth proves to be irremovable I perform a sub-umbilical colostomy, bringing out the loop through the central portion of the incision. A glass rod is passed through an avascular area in the mesosigmoid, one inch or so below the apex of the loop, and after closing the wound snugly above and below the exteriorised bowel, the emerging mesentery is anchored to the adjacent edges of the parietal peritoneum with a few interrupted catgut stitches. A few protruding appendices epiploicæ at the top and bottom of the incision are fixed to the parietal peritoneum to afford added support at these points.

The wound is sealed off with adhesive dressings and the arching anti-mesenteric border of the bowel is freely opened with a diathermy knife. Any bleeding points in the cut margins of the colon are picked up with artery forceps and ligatured at once. After swabbing out the interior of the gut with weak mercurochrome, the index finger is in-

serted into the proximal and then into the distal opening of the colostomy to make sure that these apertures are not unduly constricted.

The bowels are kept constipated for three or four days, after which time there will often be a spontaneous evacuation through the proximal stoma.

I can find no valid objections to this method of opening the bowel on the operating table as soon as the operation is completed. Gaseous distension is immediately overcome; the abdominal incision has ample time to heal before the bowels work spontaneously, and the adhesive waterproof sheets effectively protect the wound from any contamination.

A midline sub-umbilical colostomy is by far the easiest to manage; prolapse of the mucous membrane or of proximal bowel does not occur; ventral hernia is rare; the wash-outs can be accomplished readily; and above all a suitable belt with a shallow cup can be made, which will fit comfortably on the softest and most yielding portion of the abdominal wall.

On finding that the case is inoperable, it is more customary, however, for the surgeon to close the original exploratory incision and then to make a colostomy through a left iliac muscle-splitting incision.

The left iliac colostomy is fashioned in the following manner: The original wound is closed and covered with adhesive protective squares; a small curved skin incision is made in the left iliac fossa, about $1\frac{1}{2}$ to 2 inches medial to the anterior superior iliac spine, and at the junction of the outer and middle thirds of an imaginary line joining that bony prominence to the umbilicus; the flat abdominal muscles are split in the direction of their fibres, the parietal peritoneum is opened, and the pelvic colon is picked up and withdrawn through the wound.

Redundant colon is replaced into the pelvic cavity, a glass rod is passed through an avascular spot in the mesentery about $1\frac{1}{2}$ inches below the apex of the loop, the lateral lumbar gutter is obliterated with a running suture, as recommended by Rankin (fig. 297), a stitch or two is taken between the opposing surfaces of parietal peritoneum and mesosigmoid, and the wound is then closed. Adhesive sheets are applied around the exteriorised loop so as to isolate it completely,

and the bowel is opened with an electric cantery in the manner shown in figure 297.

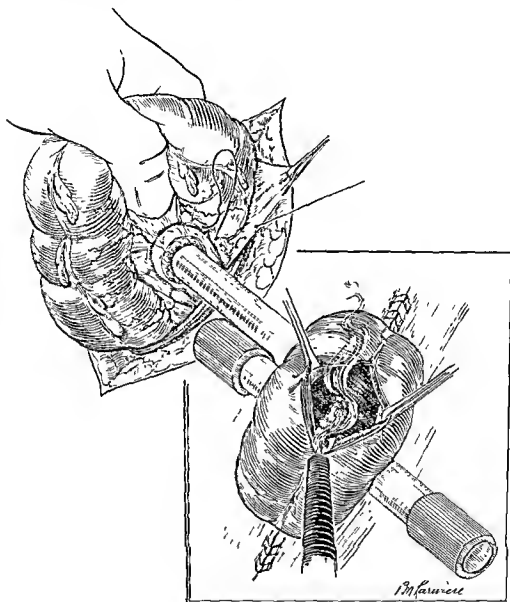


FIG. 297.—SIMPLE LOOP COLOSTOMY.

Note the position of the Rankin stitch.

Before leaving hospital all patients are carefully taught concerning the care of the colostomy. Following the scheme described by Cattell (*New England J. Med.*, 208:740, 1933) the colostomy should be under control within one month of the patient's discharge.

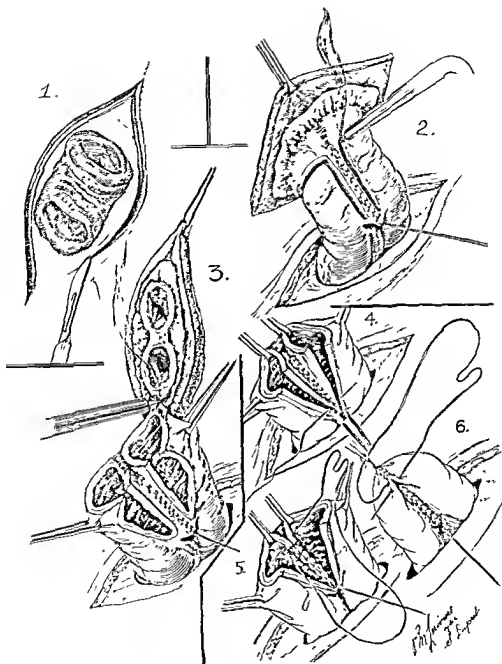


FIG. 298.—A METHOD OF CLOSING A SIMPLE LOOP COLOSTOMY—PAUCHET'S TECHNIQUE. (After Duprel.)

CLOSURE OF A LOOP COLOSTOMY

The majority of loop colostomies are performed for inoperable cancers of the rectum or distal colon and the question of closure in these cases will, of course, not arise.

Loop colostomy is sometimes carried out as a temporary measure for the complications of diverticulitis of the colon, for some non-malignant strictures of the rectum, or before the performance of certain reconstructive operations upon the mal-developed vagina or rectum, etc., subsequent closure being clearly indicated in a number of these cases.

The various steps in the operation of excising this type of colostomy and restoring intestinal continuity as practised by Pauchet (*Pratique chir.*, 19:132, 1934) are illustrated in the accompanying diagrams (fig. 298).

This combined end-to-end and side-to-side method of anastomosis which I have employed successfully on a few occasions can be recommended with confidence.

PART XI

POST-OPERATIVE CHEST COMPLICATIONS

CHAPTER 1

POST-OPERATIVE CHEST COMPLICATIONS

BY

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In its evolutionary years the spectre of surgery was beyond question the occurrence of post-operative sepsis. This menace modern anaesthesia and aseptic technique have long combined to defeat as a serious check to progress, so that the most severe and fatal complications are now met in surgically clean cases. Here progress lags sadly behind, and most markedly so in respect of the lung. Recent reviews of comparatively large series have shown that in from 10 to 14 per cent of all cases of abdominal surgery some complication follows within the chest, and that a high proportion of the total deaths after abdominal section occur from this cause. Consideration of the factors concerned and of the conditions which may occur is not therefore without point.

GENERAL PREDISPOSING FACTORS

Many of the mishaps that develop within the chest after operation are likely to be brought about by a similar combination of factors, which may therefore be briefly reviewed.

1. **Age.** Generally speaking, the older the patient operated on, the greater the likelihood of subsequent chest trouble, in view of accompanying debility and lowered resistance to infection. Infants show a like susceptibility.

2. **Sex.** Chest complications occur in men about three times as commonly as in women. The reasons for this difference in incidence are probably to be found in the greater occupational exposure of the male with higher incidence of chronic bronchitis, while the disturbing effect of immobilisation of the diaphragm after operation is likely

to be less marked in women, in whom breathing is normally more thoracic.

3. **Build.** The obese patient is a poorer operative risk than one of spare physique, chiefly from impaired facility of breathing and the greater difficulty of surgical access.

4. **Previous Illness or Infection.** Rigidity of the thorax from emphysema lowers the effectiveness of coughing and expulsion of sputum, while vital capacity is correspondingly reduced and the way paved to downward spread of infection by the accompanying bronchitis. Enquiry should be made before operation, in a suspected case, for occurrence of morning cough and sputum and, if present, the character of the latter determined. The more highly purulent its nature, rather than mucoid, the greater is the risk of subsequent chest infection.

Any acute respiratory infection, even a common cold, implies a correspondingly greater risk and for non-urgent operations calls for postponement. Obvious infection of teeth, or in some cases of tonsils or sinuses, increases the liability to inhalation of infective material. Where mouth sepsis is present any pulmonary lesion is the more likely to become suppurative, and wherever possible preliminary treatment should therefore be given.

5. **General Fitness of the Patient.** The better the general condition of the patient at the time of operation, the less probable is it that any post-operative illness will develop. The best preparation is accordingly one which involves the least disturbance of the patient's normal way of living. Preliminary purgation, starving and withholding fluids have no longer any place in treatment, and there is much to be said for maintenance of activity and muscular tone where possible until the time of operation. For procedures of choice the most suitable time should be chosen and in some cases a few days' rest beforehand is of great benefit in reducing operative and post-operative risk, and in allowing for the judicious treatment of any associated catarrh, or bronchial condition, which may also be helped by a curtailment of smoking.

Essential operations upon debilitated subjects fall into a different category. An enfeebled cachectic patient can less well withstand the trauma of an abdominal wound, while cough tends to be ineffective and breathing shallow. Although the incidence of chest affection will

inevitably be higher, recognition of these factors will indicate means to combat their effects.

6. Operation to be Performed. It has already been mentioned that abdominal rather than non-abdominal operations head the list in their proneness to chest sequelæ. Surgery in the neighbourhood of the diaphragm has the greatest incidence of subsequent lung collapse, while pelvic operations, especially uterine, are the outstanding preliminary to embolism. Sepsis in general heightens the risk and severity of all chest complications—a simple pneumonia or area of collapse not otherwise serious may as a result break down and become an abscess. Similarly chest trouble is most likely to develop following urgent operation rather than that performed as a non-emergency. The patient is acutely ill, resistance is lowered and no time is available for any preliminary treatment, while in the majority of cases, for example intestinal perforation, the factors of sepsis and peritonitis are also present.

Compared with the abdominal group, after operations on other regions the incidence of pulmonary complications sinks to the level of 1 per cent.

7. Choice of Anæsthesia. In the responsibility for chest complications the anæsthetist has without doubt received more than his just share of blame, undue stress having been laid upon this factor. Straining at induction, avoidable respiratory spasm or a partly obstructed airway are of course likely to bring about pulmonary collapse with its possible sequels, the more so when accompanied by excessive secretion, but these are factors which it should with care be possible to avoid. While it is true, therefore, that any unskillfully administered anæsthetic may determine their incidence, the confident prediction that the simple avoidance of all inhalation methods would lead to a complete disappearance of chest complications has woefully failed to materialise. The difference in incidence of chest troubles after spinal, as compared with general, anæsthesia is much smaller than would be anticipated, and is in fact denied to exist by some observers. Due regard must in fairness be given to the fact that spinal anæsthesia will as a rule be chosen in those very cases where the operative risk is already thought to be severe, i.e., in the unavoidable presence of bronchitis or cardiovascular weakness, so that the two groups are not strictly comparable. The main drawback to spinal anæsthesia lies in

the fact that it necessarily paralyses for a time the lower intercostal muscles, and so impairs respiration and cough. It is moreover frequently accompanied by a fall in blood pressure. Pulmonary collapse, in particular the so-called massive basal collapse to which detailed reference is made later, is not abolished by resort to spinal anæsthesia. Some advantages however still accrue to the use of this method, as it causes less bronchial irritation and secretion than inhalation anæsthesia, with a slighter interference also with the cough reflex. The course of the pulmonary collapse, should it occur, is accordingly simpler, with a smaller probability of septic developments in the affected lung. In a bronchitic subject, therefore, spinal anæsthesia, where otherwise suitable, still remains the outstanding method of choice for these sufferers.

Local abdominal anæsthesia is similarly no complete safeguard against complications above the diaphragm for the same reasons as spinal anæsthesia, although the risk is still further reduced. As an accessory to inhalation methods it assists surgical access, diminishes shock and minimises trauma, and by permitting a reduction in the depth and duration of general anæsthesia lowers at the same time the liability to chest complications.

A prolonged recovery stage from anæsthesia involves an equally long period of suppressed cough reflex, during which time breathing is shallow and bronchial secretions collect. These conditions are ideal for producing obstruction of the air passages, the precursor of many more serious developments. In general, therefore, the anæsthetic with rapid recovery period is the one of choice. When combined with freedom from local irritation the wisdom of this choice is enhanced. If a basal narcotic be employed, it should be one of the more quickly acting group of drugs which are not followed by a prolonged period of unconsciousness and depressed respiration. Certain methods of inhalation anæsthesia have recently come into vogue, whereby the surgeon obtains the operative benefit of quiet respiration in maximum degree on the patient's part, notably by the use of CO_2 absorption technique in closed-circuit anæsthesia. While the immediate advantages are not disputed, it must be borne in mind that the shallow breathing and poor lung ventilation involved actually prevent certain areas of the lung from expanding, with risk of accumulation of mucus and circulatory stasis therein. This liability to atelectasis,

if fully appreciated, however, may be overcome by an artificial post-operative ventilation of the lung as described later.

8. **Pre- and Post-Operative Care.** Enough has been said to show that the responsibilities of the surgeon and anaesthetist, beginning as they do before the time of operation, in no way cease as soon as the patient leaves the theatre, and that the care required before and after is no less important than the conduct of the operation itself. This aspect is discussed in more detail under appropriate sections, but the paramount need may be stressed here of avoiding depression of the respiratory centre, whether by undue depth or duration of anaesthesia or the excessive use of morphia and barbiturates before, and more particularly after, operation. Similarly the substitution, as far as possible, for the mechanical constriction of tight bandaging by local fixing of the wound with adhesive plaster obviates another important factor. Reference is made later to the correct use of atropine before operation to minimise secretions, and to the dangers which may follow its over-zealous administration in the post-operative stage.

Free bodily movement in bed, as early after operation as his condition will permit, is the patient's best safeguard against the risk of embolism by maintaining an adequate venous return, while encouragement of deep breathing with free cough and expectoration similarly protects the lung.

A classification of the more important pulmonary conditions which may follow operation are as follows:

- I. *Acute bronchitis.*
- II. *Pulmonary collapse.*
- III. *Pulmonary embolism.*
- IV. *Broncho-pneumonia.*
- V. *Lung abscess.*

I. ACUTE BRONCHITIS

Predisposing Factors. Conditions leading to the development of a simple post-operative bronchitis include the recent presence of any catarrhal infection of the upper respiratory tract, the use of an irritant form of anaesthetic, and chilling of the patient either during anaesthesia or in subsequent transit from the theatre to the ward, all factors

which it should be possible to avoid. The journey from theatre to bed should be as short and unexposed as possible, and care taken to keep the patient warm.

Symptoms. These usually develop within a day or two of operation, and consist chiefly in dry irritant cough with mild fever and sub-sternal discomfort. Diffuse rhonchi and sibili are heard over the chest. The most troublesome feature lies in the sharp abdominal pain and strain upon sutures set up by the cough. Later, the cough becomes looser with frothy sputum, which the patient should be encouraged to void freely.

Treatment. In the early stages relief is given by steam-inhalations of creosote or tinct. benzoini Co. 5i to the pint, with hot drinks, light poultices or counter-irritants to the chest, and a mild sedative linctus and diaphoretic mixture every four to six hours. Later, a stimulant expectorant is given with an alkali to loosen secretion. Morphia should be withheld or given with great care in the presence of bronchitis, tight bandaging avoided, and the patient encouraged to cough and clear the chest frequently in the position which he finds most easy and effective.

Bronchitis may be of every grade and in its more severe forms will readily pass into a clinical condition of broncho-pneumonia, as later described; the distinction is often difficult, and will be made more from assessment of the degree of illness and accompanying dyspnœa and toxæmia than from physical signs. A more stimulant line of general treatment is then indicated.

II. PULMONARY COLLAPSE

Pulmonary collapse or atelectasis, involving either scattered patches of lung tissue or, in more striking form, one or more entire lobes, is the commonest and by far the most important primary lung condition noted after operation. If unrecognised and untreated it often leads to more serious sequelæ such as bronchopneumonia, lung abscess, or the later development of bronchiectasis. Its true nature was for many years unrecognised, and its mode of production even up to the present time has been the subject of sharp controversy, but further knowledge has led to its now being readily diagnosed, while its pathology has also been satisfactorily explained.

Ætiology. As with most conditions, the ætiology of post-operative collapse does not rest entirely upon a single factor, but in 90 per cent or more of cases it develops as a direct result of bronchial obstruction. Weakness or inhibition of respiratory muscles is admittedly an accessory factor in some cases, but is of secondary importance compared with mechanical blockage of the air-passages and is seldom if ever the sole cause of atelectasis.

Collapse of the lung may be patchy or lobular in distribution, being then due to an irregular obstruction of many smaller bronchi, an accepted part of the clinical condition of broncho-pneumonia, from which it is difficult if not impossible to draw any sharp distinction. The course of events is an initial bronchitis of the finer air-passages, obstruction of some by secretion, followed by atelectasis of the zones they supply and the possible development of pneumonia in the collapsed areas. This last phase does not necessarily occur, and with prompt treatment aimed at re-expansion the chest condition may run a shorter and less toxic course, with early return of the lung to normal. The importance of early detection is obvious in the prevention of bronchopneumonia, lung abscess, or septic pneumonia. Increasing dyspnoea in a bronchitic subject, with ineffective cough and the detection of scattered silent areas, or bronchial breathing and râles of irregular distribution, indicate the likely development of lobular collapse. The treatment of this condition is discussed elsewhere in this chapter under the general heading of atelectasis.

Of more dramatic occurrence is the condition of "massive collapse," in which the greater part of a lobe or lobes, or even an entire lung, becomes shrunken and airless. This is, however, only the maximal stage of the same process, for there is overwhelming evidence that the collapse results from absorption of air throughout the lobe following blockage of its main bronchus by a thick tenacious plug of mucus. Conclusive proof is furnished by the bronchoscope, when the obstructing plug of mucus or mucopus is seen. Experimental occlusion of a bronchus in animals by an inflatable balloon similarly produces lobar collapse within a few hours, and a like process of air-absorption on a smaller scale is frequently observed clinically in the course of a severe asthmatic attack, where its rapid development and resolution may be confirmed radiologically. In the same way

more lasting atelectasis is a common sequel of new growth in the bronchus or of pressure by tuberculous glands at the lung root.

The subsidiary factors in the production of massive collapse are found in the temporary weakness or inhibition of the lower intercostal muscles and diaphragm which follows abdominal trauma, leading to shallow breathing and ineffective cough. The raised immobile dome of the diaphragm shown by X-rays is the result, not the cause, of the basal collapse, and it is noteworthy how seldom diaphragmatic paralysis deliberately induced by phrenic avulsion is followed by massive atelectasis.

Symptoms of Pulmonary Collapse. Massive collapse usually occurs on the second or third day after operation, often developing quite suddenly and becoming complete within a few hours. Some degree of bronchitis has commonly preceded it. Dyspnoea is always found to some extent, with cyanosis and a hard spasmodic cough, inadequate to expel the thick viscid sputum in the bronchi. Pain in the chest is frequent, from sudden increase in the negative pleural tension on the affected side; sometimes a sense of discomfort or obstruction takes its place. In many cases there is a sharp rise of temperature to 101° F. or higher from retention of secretions beyond the bronchial obstruction, a warning of possible suppurative change in the zone of collapse. At first sight the clinical condition may easily be mistaken for a true pneumonia, though the toxic appearance and jerking dyspnoea of the latter are usually lacking. Haemoptysis is not a feature. Differential diagnosis in most cases may be made from the physical signs in the chest. The earliest is a weakness of breath sounds over the affected lobe, a stage of collapse at which, with recognition and appropriate treatment, re-expansion may be anticipated. Later, the fully developed picture is found of a silent lobe with upward displacement of the diaphragm and shifting of the heart and mediastinum toward the affected side.

X-ray examination is not always possible owing to the acutely ill condition of the patient, but where a portable apparatus is available films should always be taken. A skiagram of a complete basal collapse will show a dense triangular shadow of the airless lower lobe continuous with the shadow of the heart, which is displaced toward it. Patchy collapse causes less well defined opacities, radiologically difficult to distinguish from broncho-pneumonia.

Course. The majority of patients with post-operative atelectasis will get well, either spontaneously from the patient's own expulsive efforts, or as a result of treatment. Within a few days the coughing up of tenacious sputum is followed by a rapid alleviation of symptoms, with relief of dyspnoea and fall of temperature to normal. In the remaining cases, however, the blockage persists, with serious consequences from infection of the collapsed lobe. Non-expansion is followed by pneumonic or by suppurative change with development of a diffuse septic pneumonitis or more localised lung abscess. Either may prove rapidly fatal, or where obstruction is relieved only after a long interval a permanent bronchiectasis may be set up. The need is clear, therefore, of securing re-expansion at the earliest possible stage.

Prevention of Collapse: Causative Factors. The cause of bronchial blockage is, broadly speaking, twofold—excessive bronchial secretion combined with inability of the patient to expel it, so that it becomes progressively more inspissated and difficult to dislodge. Measures to be taken in combating these factors may be considered according to the stage in relation to operation.

1. **Pre-Operative Factors.** (a) The presence of *oral or respiratory infection*, which by irritation will lead to an increased secretion of mucus or mucopus. Prophylaxis is by means of thorough preliminary treatment, and where necessary postponement of operation.

(b) *Low vital capacity*, as from emphysema or rigidity of the spine and thorax. In suitable cases this may be to some extent improved by breathing exercises and physiotherapy before operation.

(c) *Pre-operative medication* with morphia or intravenous barbiturates carried to excess, with resulting suppression of cough reflex. A too liberal use of depressants is clearly not the best preliminary to a prolonged anæsthetic.

2. **Factors During Operation.**—(a) *Direct irritation of bronchi by anæsthetic*, with out-pouring of mucus. This may be minimised by a judicious dose of atropine before operation to inhibit oral and bronchial secretion, together with the use of a warmed and relatively non-irritating anæsthetic.

(b) *Inhalation of infective secretions from upper air-passages*, e.g., blood or saliva from mouth, nose or throat, or in some cases stomach contents after vomiting. The danger of such aspiration is obvious,

and is to be avoided by packing off the naso-pharynx, with suction of mouth contents into a receptacle, a low position of the head and the use where desirable of endotracheal anæsthesia.

(c) *Excessive depression of respiratory centre* by unduly deep or prolonged anæsthesia, causing inadequate pulmonary ventilation and retention of secretions. Methods to improve the latter are discussed under inhalation therapy.

(d) *An unsuitable position of the patient upon the operating table*, as by the placing of blocks or heavy sandbags beneath the region of the diaphragm in upper abdominal surgery. The position adopted should be such as to permit the greatest possible freedom of respiratory movement.

(e) *Surgical methods which involve unnecessary trauma* increase the inhibition of the diaphragm and upper abdominal muscles, and so add further to the respiratory difficulties of the patient. An ill-planned incision, the prolonged use of wide retractors, or any avoidable pulling or tearing of tissues are examples of such trauma, and the benefits of care in these respects are clear.

3. **Post-Operative Factors.**—(a) *Depressed respiratory activity* after operation is the chief cause in this group. The more prolonged the recovery phase from anæsthesia, the longer is the time available for collection and retention of sputum in the bronchi. The remedy lies in promoting rapid excretion of the anæsthetic by artificial hyperpnoea at the end of operation, and the avoidance of over-prolonged basal narcosis.

(b) *The drug factor.* While drugs which abolish the cough reflex and depress the respiratory centre are harmful in overdose before operation, this applies with greater force in the post-operative stage. The indication for morphia should be pain and pain only. Mere restlessness should be treated by simpler sedatives such as bromide and chloral hydrate or one of the milder barbiturate drugs, or by attention to the immediate cause of discomfort.

Atropine also must be used post-operatively with care and discrimination. Given with too great freedom it will so dry up secretions as to make for the very type of viscid inspissated sputum which the patient has not the strength to bring up, and so provide the basis for bronchial blockage. Some authorities, indeed, go so far as to deny the wisdom of giving atropine at all after operation.

(c) *The factor of posture.* Immobility of the patient in one posture for long periods after operation delays the restoring of functional activity to the lungs, and frequent early changes of position in bed promote freedom of breathing and the voiding of bronchial secretions. Cough and expectoration are to be encouraged rather than suppressed.

In the same way sputum already collected in the bronchi should be given the greatest chance of escape. In this respect the orthodox Fowler's position is too rigidly enforced. Better facility for bronchial drainage in a weakened subject is afforded by other postures. Encouragement of cough, for example, with the patient turned temporarily first into one and then into the other lateral position, while local support is given to the abdomen, will often enable the lung bases to be cleared and prevent their becoming waterlogged, while a short period in the Trendelenburg position may be even more effective.

(d) *Avoidance of abdominal fixation.* Rigidity of abdominal muscles and diaphragm not only hampers expansion of the lung bases but restrains the efficiency of cough. It may arise from a number of factors. Of these in the early stage the most significant is pain. The drawbacks to the too-liberal use of morphia after operation have already been noted. Given with judgment, however, in the immediate post-operative period it allows of easier respiratory movement and a greater freedom of cough, without the inhibition of violent pain.

Other abdominal factors in hampering lung expansion are post-operative distension of the stomach and intestines, and encasement of the lower thorax in rigid bandaging, both of which may be avoided by appropriate means.

1. **Treatment of Pulmonary Collapse.** This will to some extent have been indicated in the foregoing paragraphs dealing with prevention. The value of early diagnosis cannot be over-stressed; the whole issue is to obtain re-expansion of the lung if possible before more serious secondary changes have a chance to develop.

Treatment should not be stereotyped, but made appropriate to the stage at which diagnosis is made. The factors already described leading to retention of bronchial secretion should as far as possible be eliminated. Wherever the circumstances of operation make pulmonary collapse a likely sequel, great benefit follows the use of carbon

dioxide inhalation. After basal narcosis, spinal anæsthesia or any prolonged abdominal operation, for example, it should always be employed, although it is not necessary for it to become a routine procedure in every abdominal case. Similarly where signs are found after operation that basal collapse is already developing, artificial ventilation by this means is of the greatest value in arresting the process. Warning will have been given by the shallow breathing, irritant dry cough and weakness of air entry at one or other base. Frequent short inhalations of a mixture containing 5 per cent CO_2 with oxygen should then be given, say for five minutes every hour, lengthening the interval as the patient reacts. In the type of case mentioned which is predisposed to collapse, treatment should be started actually during the later stage of anæsthesia and continued until the patient is fully conscious and has recovered his cough reflex. Higher percentages of carbon dioxide are neither necessary nor advisable, for while small proportions stimulate, large amounts of the gas depress respiration, are frightening to the patient and may produce other harmful effects. As improvement occurs, the frequency of administration may be reduced, say to five minutes every two, three or four hours, until breathing is unimpeded and the lungs are free from abnormal signs.

Recovery from the early stages of collapse is also helped by giving a stimulating expectorant containing potassium iodide and ammonium carbonate to promote cough, and by placing the patient, as already mentioned, in the most appropriate posture for drainage of the affected bronchi. Recovery is heralded by a change from fruitless cough to the bringing up of mucoid sputum, often as a tenacious plug, followed by a rapid re-expansion of the lung.

2. **Established Collapse.** The treatment of massive collapse when fully established, calls for great judgment. In this stage, when the bronchus has become completely obstructed, the use of carbon dioxide is not likely to be of benefit in promoting re-expansion but may on the contrary impede recovery by driving the plug of mucus still more firmly into position. If, moreover, infection of the collapsed lobe has already occurred and the patient is coughing up highly purulent sputum, CO_2 inhalations may only lead to a generalised dissemination of infection and broncho-pneumonia.

Where, therefore, signs of massive collapse continue for more than

forty-eight hours without response to simpler treatment and with no spontaneous expulsion of the obstruction, an attempt should be made to remove it by the passage under local anæsthesia of an aspirating bronchoscope, and sucking out as much of the inspissated mucus as possible. This procedure is frequently followed by a rapid re-expansion. Bronchoscopy is all the more urgently indicated where septic change is suspected, for the longer the lung is then allowed to remain collapsed the less probable, and less complete, is its eventual re-expansion. In some instances, indeed, atelectasis remains permanent, with suppurative bronchiectasis, although the obstruction has been removed. Treatment then becomes that of the secondary condition.

Accessory treatment in the more severe cases of massive collapse will also be required. In the presence of toxæmia general stimulants may be given, such as coramine, strychnine or adrenalin, together with expectorants and steam inhalations, especially where development of a broncho-pneumonia is feared.

III. PULMONARY EMBOLISM

Pulmonary embolism after operation is brought about by the attachment of a portion of blood-clot, usually from a peripheral vein of the body, and its arrest in a branch of the pulmonary artery. The effects upon the lung and circulation vary greatly according to the size of the embolus. If small, a localised infarction results, shown by pleural pain, often of sudden onset, with some cough and dyspnœa, followed later by a small hæmoptysis or the bringing-up of blood-stained sputum. Friction is usually heard over the affected area, with alteration of percussion note and breath sounds if the infarct is of sufficient size. General disturbance is usually slight. X-ray investigation will indicate the extent of pulmonary involvement. Immediate treatment of the infarct is by sedative linctus and hot local application to the area of pain, and search is made for its cause if not already known.

A large embolism, usually from an iliac or main pelvic vein, may on the other hand bring about the most tragic occurrence of surgery. A patient who has reached an apparently normal stage of convalescence may without warning succumb to a rapid suffocating death.

This grave event follows the sudden blockage of the main pulmonary artery, often at its bifurcation from the right ventricle. There is immediate and intense distress with orthopnea, lividity and severe pain in the chest, followed, if death does not directly occur, by the rapid onset of circulatory failure. Shock is marked, the pulse is feeble or imperceptible, and the veins in the neck are engorged. About half of the attacks of gross embolism of this kind prove fatal within a few minutes.

Predisposing Factors to Embolism.—1. *Type of Operation.* The common source of embolism is a large thrombosed venous channel in the lower limb or pelvis, especially the iliac, femoral or uterine vein. Operations such as hysterectomy, oophorectomy or for pelvic inflammatory conditions are accordingly the most likely precursors. The incidence of pulmonary embolism in this group varies between 0.5 and 1 per cent of cases, compared with 0.1 per cent only in all abdominal operations, with a responsibility for about 10 per cent of all deaths following abdominal section. The usual time-interval is between seven and twelve days after operation.

2. *Build of Patient.* It is in the heavily-built obese type of patient that pulmonary embolism is most likely to occur; diaphragmatic breathing and venous return are apt to be sluggish, while local obstruction may be caused by the weight of a pendulous abdomen upon the thigh.

3. *Sepsis*, by increasing the liability to phlebitis, adds to that of embolism, although the incidence of the latter is not confined to infected cases. Any local inflammatory process in the neighbourhood of the pelvic veins may spread to their walls, or organisms may be transferred from distant infected areas in the gums or throat. A warning is sometimes given, even in the absence of local signs of venous thrombosis, by the presence of slight and otherwise unexplained post-operative fever.

4. *Factors in Pre- and Post-Operative Care.* Any treatment before operation which weakens the patient or involves a reduction in body fluids, such as preliminary starvation or purging, will lead to a sluggishness of venous circulation in the limbs and predispose to thrombosis. Similarly, too great a restriction upon movement of the patient after operation will cause stagnation of blood from the lack of propulsive muscular contraction and of aspiration effect into the heart.

A position of acute flexion of the thighs upon the abdomen or pressure of pillows behind the knees increases the difficulty of venous return. When these factors are combined with free liberation into the circulation of thrombus-producing substances by surgical trauma the field is set for thrombosis and embolism.

Despite recognition of the above factors, it has to be admitted that pulmonary embolism sometimes takes place where every known precaution has been taken.

Treatment of Major Pulmonary Embolism. The occurrence of a severe embolism is in itself a sign of failure of preventive measures. Immediate treatment consists in the combating of shock, and relief where present of congestive failure. Morphia gr. 1/6 is given, with atropine gr. 1/100, combined if necessary with venesection and oxygen administration. In the gravest cases where it is clear that with these measures alone recovery is impossible, the correct treatment, although undoubtedly a hazardous one, is to attempt removal of the clot from the pulmonary artery by pulmonary embolectomy or Trendelenburg's operation. Against the big risk of failure must be set the certainty otherwise of the patient's death. Every large hospital where major surgical work is done should possess the necessary apparatus kept available for immediate use in a sterilised drum, and provide for the training of a theatre team in the steps of the operation.

Where operation is decided upon, the patient is observed until the pulse is imperceptible. Then without anaesthesia (the patient being practically unconscious) the pericardium is opened, after removing the second to fourth left costal cartilages and stripping back the left pleural sac. The main vascular pedicle is lifted out of the wound and temporarily occluded by rubber tubing; the pulmonary artery is then incised and resutured after removal of the clot by special forceps. Adrenalin is injected into the base of the aorta or into the right ventricle, the heart replaced and wound sutured. Speed of operation is of course a vital factor if the patient is to recover.

Prevention of Pulmonary Embolism.—1. *General Measures.* The problem of embolism is inseparable from that of venous thrombosis, and is concerned therefore with eliminating those factors which lead to intra-vascular clot formation. Some of these have been noted in previous paragraphs. In general the aim must be to maintain a nor-

mal venous flow. The volume of circulating blood must be kept up both before and after operation by giving fluids generously. Posture must be such as to prevent pressure upon the main venous trunks, and tight bandaging avoided. Daily massage combined with active and passive movement of the limbs should be given, beginning as early as possible after operation, preferably on the following day. The patient is encouraged to breathe deeply and to move about in bed as freely as his condition will allow. Should thrombosis of a leg vein nevertheless occur, it is best treated locally by firm strapping of the limb with elastoplast, together with the use of special measures as described below.

2. *Special Measures to Diminish Coagulability of the Blood—the Use of Heparin.* Despite the wide adoption of precautions on these lines it is still not possible to guarantee to any patient immunity from risk of embolism. Recent work, however, directed to the essential problem of inhibiting for a period the coagulating power of the blood is most encouraging, and gives hope that this disastrous complication may ultimately be overcome.

For a number of years the presence has been recognised in liver and certain other mammalian tissues of anti-coagulant substances, prepared originally by Howell in small amounts from the liver of the dog and therefore named by him "heparin." Injection of these preparations into animals had the effect of prolonging the coagulation of the blood in proportion to the dose given, although undesirable toxic effects were also produced. Later, in 1929, more potent fractions of the same type were obtained from ox-lung by the Toronto workers, A. F. Charles and D. A. Scott, and have been extensively studied. These investigators were finally able to isolate from this source a crystalline barium salt of heparin of uniform potency, from which the heparin fraction could be isolated by precipitation, washed and stored as a dry powder free from barium. From this powder a solution could be made for clinical use as required. The barium salt was shown to be a dry stable product, capable of being physiologically standardised according to its potency in inhibiting the clotting of blood. Howell had originally defined his "cat-unit" of heparin as having that degree of anti-coagulant activity required to inhibit the clotting of 1 cc. of the cold blood of the cat for twenty-four hours. The barium salt isolated by Charles and Scott was found by them

to have a potency of approximately 500 Howell cat-units per milligram.

It is probable that heparin is not a single chemical substance, but is composed of a group of esters of variable composition. It is thought to be the normal circulating anti-coagulant of the body, secreted most probably by the mast cells found in the connective tissue in and around the walls of blood-vessels. The inhibiting effect of heparin upon coagulation is probably effected through its power to activate a precursor to antithrombin, and so prevent the combination of prothrombin with thrombokinase and calcium ions which normally leads to clot formation.

The experimental studies of the above workers, among others, carried out originally upon animals, has been followed by extensive investigation of its clinical applicability to man, notably by E. Jorpes of Stockholm, and by G. D. W. Murray and C. H. Best of Toronto, who have recently published their preliminary results. It is now well established by the findings of the latter observers on more than 400 patients that purified heparin, passed through the stage of the crystalline barium salt, may be given to patients with complete safety, and without any untoward effects. The route of administration found effective in animals was by either subcutaneous or intravenous injection, preferably by continuous intravenous drip. Oral administration has no action. The clotting time is prolonged in direct proportion to the dose given, and administration is not followed by any dangerous negative phase, *i.e.*, the blood does not become temporarily hypercoagulable after the initial effect has passed off.

The clinical applications of these discoveries would appear to be wide, and include the use of heparin in the preserving of fluid blood-specimens, its employment in blood transfusion either added directly to the blood or, more conveniently, injected previously into the donor, and in surgical operations where prevention of clotting is especially desired, as in operations upon blood-vessels. By far the most vital of its possible applications, however, is in the prevention and limiting of post-operative thrombosis, and hence of pulmonary embolism. Its indiscriminate use in all post-operative cases will not furnish much exact information, but a selection of patients considered especially liable to thrombosis will enable a better estimation to be made of its value.

The evidence so far obtainable suggests that heparin will prove to be a new weapon of great power in this regard. Murray found that of his major abdominal cases, in the heparinised group no deaths from pulmonary embolism occurred, in contrast to a mortality of between 2 and 7 per cent in a carefully controlled series not receiving heparin; while of a group of 22 patients who had already had repeated pulmonary emboli of smaller grade prior to being given heparin none succumbed after its administration was begun. It would therefore seem worth while to include in the indications for heparin the occurrence of a warning pulmonary infarct or development of femoral thrombosis. It has been shown that increase in size of a commencing thrombus by accumulation of thrombocytes or fibrin has been prevented by the administration of heparin and the flow of blood through the vein maintained, with retraction and organisation of the fibrin already formed.

Technique and Dosage of Heparin Administration. As no method is yet available whereby heparin may be estimated in the bloodstream, the assumed liability of a patient to post-operative thrombosis must still be a matter of clinical judgment. Theoretically it should be possible to determine the required dosage of heparin by periodic estimation of the coagulation time, since in man 1 mgm. of heparin per kilogram body weight, given intravenously, raises the coagulation time to approximately forty minutes.

At this stage of knowledge the optimum dosage is still a matter of observation, and that advised varies with the preparation given. Murray suggests that using the Toronto preparation the average requirement is one of 750 to 1000 units per hour, regulated in accordance with the individual patient's observed clotting time, and given by continuous intravenous drip, diluted to the required strength with normal saline solution. British Drug Houses Ltd., in co-operation with Dr. E. Jorpes of Stockholm, have made available in concentrated form for easy intravenous injection a preparation of heparin in sterile 5 per cent solution, *i.e.*, containing 50 mgm. of heparin per cc., with an activity of 500 cat-units per milligram. The dose of this preparation recommended for use in treatment of cases of thrombus formation is 75 to 150 milligrams given intravenously in the form of the 5 per cent solution, the dose being repeated every third or fourth hour, four to five times a day, until the condition

of the patient indicates that it may be reduced with safety. Similar treatment is indicated for the prevention of thrombosis after surgical operations, the first injection being given four hours after completion of the operation.

It is considered wise to delay the onset of heparin treatment in this way until sufficient time has elapsed after operation for immediate bleeding to have ceased, in order to prevent the development of local hæmatomata from too early interference with coagulation. Murray and Best suggest that this interval should be from four to twenty-four hours according to circumstances. It is recommended that, when once embarked upon, administration should be continued until the occurrence of embolism is clinically unlikely from lapse of time, and the patient has recovered sufficiently to allow a resumption of normal muscular activity, *i.e.*, over a period of say seven to ten days. By that time the wound should be soundly healed and circulation restored to normal.

One of the present practical difficulties of heparin treatment lies in its great cost, but with its more extensive use this will presumably be overcome.

IV. BRONCHO-PNEUMONIA

Post-operative broncho-pneumonia may be either a diffuse involvement of the lungs by a downward spread of infection in an enfeebled subject, of onset usually within a few hours of operation, or a more localised affection occurring at a later stage from secondary pneumonic change in an area of lung already collapsed.

1. **Diffuse Broncho-Pneumonia.**—*Predisposing Factors.* These include any antecedent catarrhal infection, old age, low general resistance from other disease or severity of acute illness, while in some cases direct aspiration of infective material into the lungs may be the cause.

Symptoms. The clinical picture of diffuse broncho-pneumonia is well recognised. Operation is shortly followed by an abrupt rise of temperature, with dry irritating cough, rapid shallow breathing and cyanosis. Toxæmia is evident in the dry tongue, mental clouding and feeble pulse, while in bad cases the patient becomes prostrated and stuporous, sinking down in the bed. Recovery in such circumstances is of course unlikely. In less severe cases the patient may weather the

storm after prolonged illness. Physical signs in the lungs do not always reveal the severity of affection; usually coarse bronchitic râles are heard over both lower lobes, with signs of patchy consolidation, if time for their development allows.

2. Broncho-Pneumonia Secondary to Atelectasis.—*Predisposing Factors.* These have already been noted in the section upon simple collapse. The greater the debility of the patient and the element of septic infection the more likely is pneumonic change to occur.

Symptoms. The development of pneumonia usually follows upon that of basal collapse after some days, and is hence of more insidious onset than the generalised form and usually affects one lower lobe only. The transition is shown by a greater severity of illness, with higher fever, increased dyspnoea and the bringing up of highly purulent or blood-stained sputum. Where the damming up of secretions by bronchial obstruction is complete, an actual suppuration and breaking down of lung tissue may develop, bringing about a diffuse septic pneumonitis or a lung abscess, while empyema may further complicate the picture.

Treatment of Post-Operative Broncho-Pneumonia. In the diffuse fulminating type of post-operative broncho-pneumonia the prognosis is grave from the start, and treatment is necessarily confined to general measures to resist toxæmia and maintain respiratory function. Nursing and fresh air are both of paramount importance, while the largest volume of fluid which the circulation will support should be administered by all available routes. Fluid diet may be supplemented by glucose and alcohol. Oxygen should be given continuously through a double nasal catheter or by means of an oxygen tent. Cough is encouraged by hot drinks and stimulating expectorants containing ammonium carbonate or chloride, potassium iodide and an alkali such as potassium citrate or sodium bicarbonate to render the sputum looser and easier to bring up. Sedatives are to be avoided, especially morphia and heroin. Cardiac embarrassment is treated by venesection and injection of salyrgan and one of the rapidly acting group of central stimulants such as camphor, coramine or cardiazol. Caffeine, adrenalin and strychnine are other valuable stimulants. Digitalis and strophanthin are of little benefit where the cardiac rhythm is regular.

Where facilities are present the sputum should be examined bacteriologically, and if the predominating organism is a *Streptococcus*

or a pneumococcus benefit may follow the giving of sulphanilamide or M. and B. 693. Infection is usually mixed, however, and the dramatic response of lobar pneumonia is seldom seen. Treatment by specific sera is similarly of little value. Quinine is thought to be of some benefit, given by intramuscular injection as solvochin or transpulmin, one ampoile of 2 cc. once or twice daily.

In the case of secondary pneumonia developing in a collapsed lobe the need is urgent, where possible, to relieve the underlying bronchial obstruction. Bronchoscopy under local anæsthesia should be carried out, if necessary repeatedly, with aspiration of secretions as already described. In other respects the treatment is essentially stimulant, as for generalised broncho-pneumonia.

V. POST-OPERATIVE LUNG ABSCESS

Breaking down of the lung substance with formation of a localised abscess may, as noted, complicate the occurrence of massive collapse. If the multiple embolic abscesses of the lung from septic infarction be excluded, however, lung abscess is not a common sequel to abdominal operation, being much more frequently seen after operative procedures upon the nose and throat, as a result of septic inhalation. A brief description will therefore suffice.

Symptoms. The onset of a lung abscess is usually shown by the development of acute respiratory illness at an interval of a week or longer after operation. High intermittent fever is frequent, with sweats, rigors and marked prostration. Distressing spasms of cough add to the patient's discomfort, at first dry and painful, but later, with increasing severity of illness, often culminating in the sudden expulsion of pus in large amount from rupture of the abscess into a neighbouring bronchus. The pus is of offensive smell and may contain elastic fibres or fragments of lung tissue. Hæmoptysis is a common feature. The degree of communication with and drainage into a bronchus may be of every grade, from complete absence, when the patient may die of toxæmia with unruptured abscess, to a rapid spontaneous cure. Usually it is partial and intermittent, with coughing up for many weeks of purulent sputum in large but variable amounts and a corresponding fluctuation in the degree of general illness. Physical signs in the chest are similarly uncertain, and diagnosis

depends much more upon symptoms; with a deep-seated abscess they may be practically absent. When the lesion is nearer the surface, signs of consolidation are present, with or without effusion. Diagnosis is greatly assisted by X-ray examination in various planes, when the rounded shadow of the abscess may be identified. Characteristic fluid levels may be seen in some cases after communication with a bronchus has been established.

Confirmation of the diagnosis and sometimes the revealing of its immediate cause may be obtained by lipiodol injection and still more by bronchoscopy, which has an important part also in treatment.

Treatment of Lung Abscess. Treatment of abscess of the lung is invariably medical in the early stages, at least until such time as the inflammatory process has become walled-off by a protective barrier of reaction in the surrounding lung tissue. A certain proportion, moreover, about 20 per cent of all lung abscess cases, will recover without operation by spontaneous rupture and drainage. In the acute phase, therefore, treatment should be planned much on the lines as for a case of pneumonia, with regard to nursing, diet and general medical care. Fluids and stimulants are to be given freely. As soon as evidence is forthcoming from the sputum that communication has become established with a bronchus, postural drainage in the optimum position for the particular patient should be begun, and persisted in, being a measure of great benefit in keeping the abscess cavity empty and promoting free drainage and healing. Where a specially constructed bed, such as the Nelson bed, is available, the correct posture may be maintained for long periods, keeping the sound lung uppermost, especially during sleep. Intermittent drainage by postural coughing is also to be encouraged.

Drugs are of relatively less importance than general measures in treatment. Steam inhalations with volatile oils are helpful and the giving of creosote and similar drugs, by mouth or by inhalation, relieves the patient and his attendants of the distressing odour of the sputum. Cough is promoted throughout the illness by simple alkaline expectorants, and the use of depressant drugs is kept to a minimum. Where abundant Spirochaetes and anaerobic organisms are found in the sputum, arsenic by mouth or by injection is of value. The instillation of antiseptic oils such as gomenol solutions into the trachea sometimes assists drainage of the lung cavity.

The role of bronchoscopy in lung abscess has been mentioned. In any case in which improvement on medical treatment is not rapid, this investigation should be carried out. In a proportion of cases drainage of the affected zone may be established or improved by the unblocking of an œdematous bronchus supplying it and aspiration of secretions distal to the obstruction. A good result may call for a repetition of the process, but frequent disturbance of the patient for this purpose is undesirable. If satisfactory drainage is not early established by bronchoscopy it is not likely to follow repeated attempts.

If progress is satisfactory, with progressive lessening of sputum and subsidence of fever, no further measures of treatment will be needed. When, however, the patient steadily deteriorates or fails to improve after an interval say of four to six weeks of medical treatment conscientiously carried out, direct surgical drainage of the abscess is called for. The most satisfactory procedure is to carry out external drainage in two stages. At the first operation a portion of the nearest overlying rib is resected and the parietal pleura incised. Unless this is already firmly adherent, the wound is packed with iodised gauze, or alternatively the margins of the pleural opening are stitched firmly to the underlying lung. After an interval of seven to ten days, when the general pleural cavity may be assumed to be safely shut off and protected, the lung abscess is freely opened with the diathermy cautery and a large drainage tube inserted.

Successful drainage is shown by a rapid improvement in the patient's symptoms, with eventual healing of the chest wound, of which however care should be taken to prevent too early closure before all suppurative change has cleared up in the underlying lung.

Perhaps the most difficult point to decide in the treatment of lung abscess is the stage at which surgical interference should be advised. Recent tendencies have been toward earlier operation, a change of view undoubtedly justified in its results, since drainage too late, while saving life, often leaves a tough-walled abscess cavity with permanent sinus and bronchiectasis.

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